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S & T PROGRAMMES OF CSIR

FOR

SEVENTH FIVE YEAR PLAN
(1985-90)

VOLUME II - PART III

BIOLOGICAL SCIENCES

75

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BIOLOGICAL SCIENCES

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AREAS CONTAINED IN THIS VOLUME

	Page
* Post Harvest Technology	1
* Leather	29
* Natural Products (Cultivation and Processing)	53
* Industrial Toxicology	75
* Applied Biology	105
* Biotechnology	129
* Cellular and Molecular Biology	165
* Drugs and Pharmaceuticals	207

Post Harvest Technology

AREA: POST HARVEST TECHNOLOGY

Participating Laboratories

- Central Food Technology Research Institute, Mysore .. CFTRI
- Central Institute of Medicinal and Aromatic Plants, Lucknow .. CIMAP
- National Botanical Research Institute, Lucknow .. NBRI
- National Institute of Oceanography, Goa .. NIO
- Regional Research Laboratory, Jammu .. RRL (JU)
- Regional Research Laboratory, Trivandrum .. RRL (T)
- Tocklai Experimentals Station of the Tea Research Association, Calcutta .. TES
- CSIR Complex, Palampur
- National Chemical Laboratory, Pune .. NCL

AREA: POST HARVEST TECHNOLOGY

Contents

		Page No.
1.0	Review of Progress and Achievements	3
2.0	Perspectives	16
3.0	S&T Programmes for the VII Plan	19
4.0	Major Infrastructural Needs	26
5.0	Financial Projections	28

1.0 REVIEW OF PROGRESS AND ACHIEVEMENTS

1.1 PHYSICAL OUTPUT INDICATORS

1.1.1 Hard output

Development of technologies amenable for industrial production for processing agricultural produce to meet consumer needs of food, pharmaceuticals, and the strategic needs of the country.

i) Number of technologies released/in production

Nearly 120 such post-harvest technologies have been released, out of which 75 are in production. The major ones are:nutritious foods for children, emergency rations for the seafarers, canned drinking water, soft drink beverages,instant mixes for the traditional foods, value-added products from spices, and coconuts, efficient milling methods for cereals and legumes, methods for beneficiation of food materials, non-toxic pesticides and procedures for their safe application. Production of citric acid, gibberellic acid, essential oils from aromatic plants, bottled coconut water.

ii) Technologies for rural development

Technologies for rural development have been developed bearing on the resources within the reach of the rura l folk. The important items are: technologies for primary processing of foodgrains, weaning foods based on millets, small-scale wheat milling,process and mill to obtain bakery flour, rodent control technologies and fumigation of grain and seed storage with non-toxic protectants (CFTRI).

Extractives from medicinal/aromatic plants (citronella java, Japanese mint, bursaria and pyrethrum) (CIMAP).

Non-agricultural industrial seed resources (mucilages, gums, proteins and lipids), winged bean, superior strains of soya-bean and edible mushrooms, guar bean, germ plasm bank, energy plants, hydrocarbon producing plant species (NBRI).

Solar drier for preservation of crops, processing of mushrooms, post-harvest processing of hops, utilisation of apple pomace (RRL, Jammu).

Extension of life of coconut leafthatch (RRL, Trivandrum).

Rutin bearing eucalyptus, standardised condition for extraction (CSIR Palampur).

Tissue culture technique, multiplication, coconut, cashew, mango tree (NCL).

iii) Technologies for social welfare

Energy food, weaning food based on germinated millets (CFTRI).

Self-employment programme for rural youth and rabbit farming RRL (Jammu)

iv) Technologies for saving raw materials

Title	Nature of saving
Mushroom cultivation	Utilisation of paddy straw
Pectin from fruit wastes	By-product utilisation
Liquid fruits	Better utilisation of pulpy over ripe fruits
Papain from papaya	Better utilisation of raw material
Leaf cup machine	Utilisation of waste leaves/ sheets

v) Technologies for saving energy

Laboratory	Nature of technologies
RRL, Jammu	Hydrocooling systems
NBRI, Lucknow	Plant biomass and petro-crops
CFTRI, Mysore	Algal technology and integrated biomass utilisation

vi) Technologies for improving quality/productivity

Laboratory	Process	Nature of improved quality
CFTRI	Germinated ragi based weaning food	Increased calorie density and paste viscocity
-do-	Citrus juice extractor	Increased productivity and reduction in bitter principle
-do-	Mini-rice mill	Higher yield of head rice
-do-	Filterpad for removal of aflatoxin	Safer quality of groundnut oil
TES	Tocklai fermentation	For improved tea quality
RRL (T)	Bottling of mature coconut water	Waste utilisation and saving tender coconut
-do-	Dry grinding process	White pepper production and improved quality
NIO	Mussel culture	Increased production under natural conditions

vii) Technologies for national security

CFTRI	Canned drinking water	For use by Army and Navy
-do-	Emergency ration	For use by Army, Navy and Air Force
-do-	Monitoring kits	For micro detection of toxic substrates
RRL (T)	Flames retardant coir and cooking leaf thatch	Safety from fire hazard

viii) Technologies for resource exploration and exploitation

- Nil -

ix) Nationally important infrastructure created

1. International School of Milling Technology

2. Food safety evaluation and monitoring of contaminants

1.1.2 Soft output

i) Major R&D achievements (highlight results, applications and impact)

a) Basic Research (findings, concepts, ideas and theories)

CFTRI - A method for in vivo production of B.thuringiensis to eliminate capital intensive production systems

-do- - Physico-chemical and histological data on rice varieties to define quality criteria bearing on identification, milling and cooking

-do- - Cottonseed protein concentrate free from toxic gossypol

-do- - Insight into the mechanism of corrosion in food cans and extraction vessels

-do- - Biochemical data on the effects of active principles of spices

-do- - Novel chemical reaction leading to synthesis of food flavours (carvyl acetate/carveol/carvone from limonene, methanyl/allylic/benzyllic esters, phenyl/1-phenyl ethyl esters, and butyl disulphide with a flavour note resembling asafoetida volatile oil

-do- - Decontamination of pesticide residues from fruits and vegetables by detergent action and extraction processes

CFTRI - Selective food protectants based on metabolic action of tricalcium phosphate and meta-H-Halloysite on insects and non-toxic to man. New physico-chemical quality control methods for predicting biological activity

-do- - Understanding of cell membrane biology under nutritional stress conditions

RRl(T)- Deformation and fraction studies of natural fibres with reference to failure mechanisms in lignocellulosic materials

-do- - Identification of flavour constituents in roasted coconut

RRL(J)- Isolation of insect hormone mimic from plant sources

TES (Jorhat) - Clonal propagation of tea varieties and shade plants

(b) Applied Research

CFTRI - Synthesis of Bromophos from non-insecticidal isomers of BHC to prevent its obsolescence

-do- - A process for microbial rennet

-do- - Process for obtaining chitin/chitosan from prawn waste and squilla

-do- - Process for obtaining alcohol from tapioca starch using microbial amylase and amyloglucosidase enzymes and subsequent fermentation

-do- - Process for high fructose syrup using glucose isomerase to supplement cane sugar supplies for food and beverage industry

-do- - Infant food formulation with lower levels of milk solids resulting in reduced cost and renal load in infants

-do- - Fermentation of cocoa beans and processes for cocoa mass, cocoa butter and powder

CFTRI - Colorants derived from safflower, Kokum and beet as substitutes for synthetic colours.

- Transesterification process for increasing the yield and quality of n-triacontanol a plant growth regulator derived from tea waste and application in the tea gardens.

TES (Jorhat) - Control of noxious weeds in Tea gardens with glyphosate solubilisation technique in formulation.

" - Root rot control by fumigation techniques in soils.

TRS - Tea chemistry with reference to thearubigins as the compounds of colour of made tea.

RRL (T) - Process for ginger oleoresin with fresh flavour.

ii) Publications (Number):**

Institutes	International	*Indian	*House Journal	Books/ Journals	Technical Reports
CFTRI	184	218	69	13	25
CIMAP	50	15	-	-	-
NBRI	24	20	4	7	-
RRL (Jammu)	15	45	5	5	-
RRL (Triv.)	21	12	4	-	-
TES (Jorhat)	-	25	-	11	115

(*Scientific papers) (** PHT area only)

iii) Papers presented at International Conference:

CFTRI 76

iv) Patents filed and sealed:	Filed	Sealed
CFTRI	9	1

v) Surveys:

[illegible] 19

.2 Sponsored Projects

Institutes	Total no. taken	Total money recd.	No. of projects completed	Value of projects exceeding Rs.10 lakhs
CFTRI	16	45 lakhs	6	Nil
TES	1	12.20 "		1

.3 Services Provided Indicators

CFTRI

i) Statutory services

(a) Analysis of apellate samples for Ministry of Health in Southern Region.

(b) Analysis of samples for I.S.I., Department of Food, DGHS, AGMARK, FPO, MFPO.

(c) Toxicity studies on pesticides/insecticide samples for Central Insecticide Board.

TES (Jorhat)

(a) Pesticide residues in made tea.

(b) Agrochemical biological evaluation.

ii) Others

Consultancy services of various kinds:

(a) Feasibility reports	19 (CFTRI)	1275 (TES)
(b) Literature survey	29 (")	30 (")
(c) Design engineering (supply drawings)	258 (")	6 (")
(d) Erection and commissioning of plants	33 (")	-
(e) Assessment of clients' R&D programmes	7 (")	126 (")
(f) Analysis/interpretation/ validation	38530 (")	-
(g) Trouble shooting and assistance	15 (")	-
(h) General consultancy advice	2210 (")	756 (")

1.4 Financial Earning Indicators (Rs. in lakhs)

	CFTRI	TES
i) From sponsored research	45	10.8
ii) From consultancy/royalty/premia/analysis and testing/publications	15	40.7
iii) External funding for projects/facilities	66	-
iv) Value of production as a result of exploitation of products and processes developed by the Institute and value of savings on		

foodgrains due to utilisation of disinfestation techniques developed	35640	-

1.5 Education and Training Indicators	CFTRI	TES
i) Ph.D. Output: Institute's personnel	24	3
Universities (CFTRI)	14	9

ii) Training courses:

(a) M.Sc. (Food Technology - 2 years duration)

(b) M.Sc. (Food Science - 2 to 3 years duration)

(c) Wheat Milling (10 months duration)

(d) M.Phil. (Seed Pathology - 1 year's duration)

(e) Practice School Program of B.I.T., Pilani (3 months duration)

(f) Faculty improvement of staff (BE/AMIE)

	(i) Number of participants		(ii)					
Institutes	Institutes personnel	From Universities	(a)	(b)	(c)	(d)	(e)	(f)
CFTRI	24	14	75	12	45	30	40	5
TES (Jorhat)	3	9	-	-	-	-	-	-

iii) Short-term training:

CFTRI

(a) Indian participation only (National)
(Fruit & Vegetable Technology, Baking Technology, Modern Abattoir Practices /Meat Processing/, Meat-Fish & Poultry Technology, Testing of Packaging Materials, Leaf Cup Manufacture, Sensory Evaluation of Foods, Foodgrain Protection).

(b) International participation
(Food contaminants monitoring, Organisation and Management of Food Industries, Environmental Contaminants in Foods, Food Handling and Storage)

(c) Specialised training:

(Fumigation techniques, Basic and Food Microbiology, Quality Control of Oil and Oilseeds, Leaf Protein Extraction and Analytical Techniques, Amino Acid Analysis)

Institutes	(iii)		
	(a)	(b)	(c)
CFTRI	657	95	76
TES (Jorhat)	1300	(Short Training Courses in Tea Field Management and Technology of Tea)	

AREA: POST HARVEST TECHNOLOGY

Linkage of pre-harvest with post-harvest technologies

The Post-harvest Technologies have been developed by CIMAP (Lucknow); CFTRI (Mysore); NBRI (Lucknow); RRL (Jammu); RRL (Trivandrum); CSIR Centre (Palampur); Tea Experiment Station (Tocklai); NCL (Poona); and CDRI (Lucknow). Those are related to the processing and utilisation of most of the crops and harvested materials for food, industrial, drug and other purposes. Therefore, post-harvest technologies are inherent and integral part of their conversion to final products from the plant crops, the raw materials. ICAR, Coffee Board, Tea Board, Silk Board, Agricultural Universities in the States, Departments of Agriculture and Horticulture of the States have provided emphasis on the production of ecologically compatible crops in the different regions of the country.

The pockets of surplus production due to intensive agriculture and plantation activities have been created in the country. The surplus production of commodities are available for processing. Expansion of the areas of high yielding oil-seeds, pulses, fibre crops and plantation products, including spices, has been responsible for creating pockets, where more and more integrated and sophisticated post-harvest technologies are to be employed.

Intensive work of the NBRI and CIMAP have given opportunity for specialised crops - aromatic flavouring agents, spices, drugs, pharmaceutical and nutritional properties, energy crops (fuel) and other specialised

products. Thus, the future post-harvest technology requires integration with the development and trend of agricultural production, both in quality and quantity. Utilisation of plant wastes and bio-mass have been the concurrent requirements of larger production of the main crop harvests. With higher food grain production (142 million tonnes), the by-products like bran, germ, husk, straw, bagasse, weeds, pith, and other agricultural wastes require post-harvest processing and utilisation. Centralised processing of oil-seeds or sugarcane or cotton seed or tobacco or spices and all plant crops have opened up vast raw materials to be used for value added and natural products. Processed pulpy fruits yield seeds as by-product, which could be a profitable industry. Tea waste to serve as a source of caffeine, baggasse and agricultural waste and straws for manufacture of furfural, expanding and supply of edible-oils, utilisation of agricultural wastes for energy and cellulosic wastes for food, fibre and microbiological products would need future attention.

Agricultural production of edible oil seed crops have fallen behind in the requirements, which is prompting for development of more newer processes for oilseed, exploitation and finding newer sources and biotechnologies for augmenting resources.

The integration of the technologies of the pre-harvest with the post-harvest, particularly for post-harvest conservation, is a very vital requirement of the years to come. The pre-harvest conditions often determine storage and conservation characteristics, physiological changes and other inherent quality parameters during post-harvest handling,

processing, storage, distribution and consumption. During the 5th and 6th Plans, attention has been given by the CSIR and ICAR laboratories on the threshold and interfaces of pre- and post-harvest technologies. Pre-harvest prophylaxis as has been investigated by the CFTRI and was noted to exert profound influence on the post-harvest behaviour and quality of fruits, vegetables, grains and other products. National application of such techniques can revolutionise post-harvest handling and conservation of selected commodities like paddy, pulses, oilseeds, millets, fruits, etc., under Indian conditions.

The development of post-harvest technology will have to meet the requirements of the production of various crops at different pockets of the country, particularly the areas where surpluses of the crops are produced and due to the quality the prices obtained by the farmers become non-remunerative.

Cereals	140×10^6 tonnes
Pulses	14.5×10^6 tonnes
Oilseeds	13×10^6 tonnes
Fruits and vegetables	100×10^6 tonnes
Spices, tea, coffee (all plantation crops)	10×10^6 tonnes

have reached the above levels of production in the country, but the productions are particularly oriented to the agro-ecological and agro-economic situations available for the crops. Thus, pine-apples in eastern sector of the country, oranges in six pockets, apple in Himachal Pradesh, walnut

in Kashmir valley, rice in high rain fall and irrigated areas, millets in comparatively dry regions, groundnut in Sowrashtra, AP, Karnataka and Tamilnadu, soyabean in Madhya Pradesh, pulses in Madhya Pradesh, coffee in Coorg and western high land area of Deccan Plato and fibre crops like jute in West Bengal and Orissa, cotton in Gujarat, AP, Karnataka; fruits and vegetables in Uttar Pradesh are some of the examples of concentrations of crops governed by the climatological and other factors. These geographical distribution may dictate the location of the post-harvest processing centres.

Plants for drugs and pharmaceuticals are being grown in various agro-climatic zones, post-harvest handling and processing are integral parts for their exploitation.

During the 7th plan, the post-harvest technologies should give emphasis for basic and applied work, keeping in view the dynamics of pre-harvest sector:

a) Perspective of resources/food augmentation

b) Generation of new energy conversion and cost effective technologies

c) Post-harvest practices aimed at safer and suitable environmental equilibrium

d) Frontier areas for innovations for post-harvest technology

e) Rural development, employment generation and welfare

The above perspectives for the 7th Plan are in conformity with the Technology Policy Statements (TPS) of the Government of India, and also the 20-Point Programme of the Government of India.

2.0 PERSPECTIVES

(a) National Needs

i) The trend of urbanisation, migration from rural sector, rural and urban industrial development, improvements in the communication, increase in the standard of living and per capita earnings have led to more explicit demand for semi-processed, processed and ready-to-use foods in the urban conglomerations and industrial colonies. The rate of this development is of the order of 6 to 7% per year on all India basis.

ii) The linkages of markets with roads and railway net-works from agricultural, forest vegetation, plantations, coastal area and other producing and harvesting centres of food and industrial plant and animal products, have significantly created demands and requirements for large-scale transportation, unit pack dispensing of foods, composite meal packets and related products.

iii) The specialised need of the country for the defence, naval expeditions, sports and antartica programmes during the recent years have enlarged very rapidly the demands for the types and food contents.

iv) The regional preferences and diverse agro-ecological factors in distinctly seven climatological and ecological zones of the country are also responsible for developing strategies for post-harvest conservation, transportation, packaging and distribution as a dynamic system. Newer approaches for the development of such products for bulk handling and at the same time in storable packs.

v) The CSIR's contributions in the field of economic plant resources, industrial, pharmaceutical and drug uses, have opened up possibilities of newer industrial pockets and belts in the country, in conformity with the raw materials produced in the specialised plantations and large gardens.

vi) The advances in R&D by the ICAR and State Governments intensive agriculture have also changed the character, concentration and pattern of availability of raw materials in some regions of the country. Fibre, sugar, food crops, oilseeds, drug plants, tobacco, spices and aromatics, beverage crops like tea, coffee and cocoa, in different locations of the country have opened up need based requirements for post-harvest processing, utilisation and related technologies.

vii) The Regional Research Laboratories of the CSIR and the Central Food Technological Research Institute, Mysore; National Institute of Oceanography, Goa; NBRI and Central Institute of Medicinal and Aromatic Plants, Lucknow have explored diverse raw materials and also the processing technologies for their economic utilisation.

(b) International trends

i) The international trends in the area of post-harvest technology are directed at bulk handling and transportation, storage in silos and directly related to large scale production of crop plants and large industrial processing establishments.

ii) In recent years, the basic technologies such as Tissue Culture, Genetic Engineering and Clonal Technique are being increasingly employed for development of a specific food, drug, biochemical or industrial material.

iii) The development of biotechnology in recent years is tending towards automation, continuous cultures, bio-reactors, immobilised enzyme technology for production of food, flavour, drug and other industrial materials.

iv) Recognition of the possible effects of toxic substances such as pesticide residues, heavy metals, mycotoxins and environmental pollutants both on the eco-system and human health, has led to the international trend towards the use of natural or biosynthetic materials instead of synthetic compounds. Biological control of pests, production of semio chemicals (behaviroral compounds), integrated pest population management and related fields are receiving increasing inputs to their R&D.

v) The emphasis on single cell protein and leaf protein is dwindling, while the development and production of strains with low concentrations of free nucleic acids are receiving greater attention.

vi) Newer sources of energy for post-harvest technologies of food, feed, drug, fibre and industrial plant materials are being tested and being integrated with the conventional energy intensive processing, unit operations and manufacturing plants.

vii) The future world supplies of food, drugs and industrial materials would have to come from the territorial waters, deep sea, ocean and far-flung continents like Antartica. Exploration and utilisation of such resources have received intensive attention during recent years.

3.0 S&T PROGRAMME FOR SEVENTH PLAN

R&D Perspectives	Linkages with *TPS	*20 Point Programme	Collaborators/ Ministries/ Users
1	2	3	4
A. CONTINUING PROJECTS			
(a) Resource/food augmentation			
(i) Comprehensive food-grain (cereals/legumes millets) processing technologies for optimum integrated utilisation of agricultural produce, their by-products and energy reduction at home and industrial level (CFTRI)	3.4 3.6 4.1	3, 20	ICAR, Ministries, Industry

(*For key to TPS and 20-Point Program of Govt. of India, see page No. 27, 28)

1	2	3	4
ii) Technologies for processing and optimum utilization in cooking practices of materials bearing oils and fats aimed at self-sufficiency in edible oils.	2.2, 3.6 4.1	20	ICAR, Ministries, Industry
iii) Rationalisation of varieties of cereals and other foodgrains for specific uses based on well defined biological and technological parameters (collaboration with ICAR in their breeding programme) (CFTRI)	3.4, 3.6	20	-do-
iv) Biopesticides processing and PHT for application	2.3	20	Ministry of Health, Industry
v) PHT systems of temperate high altitude fruits and drug plants (CSIR Complex, Palampur)	4.3, 3.6	3	ICAR, Ministry of Commerce, Health
vi) Comprehensive technologies for increasing sea food harvesting and production from mariculture aimed at augmenting resources (NIO)	3.6	3	Dept. of Ocean Development
(b) <u>Generation of new energy efficient and cost effective technologies</u>			
(i) Development of synthetic/bio-synthetic food additives (flavours and taste enhancers) as supplements for expensive spice extractives (CFTRI)	3.3, 4.6, 4.2	20	Export Promotion Councils
(ii) Technologies based on enzyme processes for production of fruit based nutritious and natural beverages, including lactic fermentation of cereals as thirst quenching beverages (CFTRI)	3.3, 3.6, 4.2, 4.6	20	Industry
(iii) Food carbohydrates/starches - their comprehensive studies to understand the chemical complexities and biological functions and uses, and industrial applications (CFTRI)	3.6, 4.2	20	Industry

1	2	3	4
iv) Petro crops/hydrocarbon plantations screening and propagation of plants for their potential for producing petroleum like products, rubber and lubricants (inter institutional)	3.3	12	Ministry of Energy
v) Hydro-cooling system for perishable fruits in remote area (RRL-J)	3.2, 3.3, 3.4	3 12	Ministry of Agriculture
vi) Value-added products from spices and spice products including oleoresin (RRL-T).	3.6	3	Ministry of Agriculture, Industry
vii) Technologies for flavoured teas and tea based beverages (TES)	2.3, 4.6	20	Tea Board
(c) Post-harvest practices aimed at safe and stable environmental equilibrium			
i) Recycling of industrial/ domestic residues for raising biomass. fish and poultry (CFTRI)	3.5, 3.6	3 10	Dept. of Environment
ii) Extending food supplies by the identification of methods for elimination of anti-nutritional and toxigenic principles in protein bearing food materials for upgrading plant proteins (CFTRI)	3.6, 4.2 4.3	15 17	Ministry of Health
iii) Development of practices to ensure safe environment, sanitation and hygiene in food establishments, including monitoring/decontamination of toxic residues and enterotoxins in edible materials (CFTRI)	3.5, 3.6	10	-do-
(d) Frontier areas for innovations in Post-harvest Technology			
i) Development of bio-reactors and stable immobilised food enzyme systems for food processing (CFTRI)	2.2, 3.4, 4.1 4.5 5.1	20	Industry
ii) Preservation of germ plasm of national food, aromatic, drug and industrial resources by tissue culture and clonal systems (Multi-institutional - specialised institutes of ICC)	3.4 4.6	3 20	ICAR, Ministry of Agriculture

1	2	3	4
(e) Rural development, employment generation and welfare			
i) Efficient technologies for manufacturing India's traditional foods, including their production, sanitation and packaging for meeting the needs of work force in urban and rural sectors (CFTRI)	2.3 3.2 3.4 3.6 4.3 4.5 4.6	17 20	State Governments, Industry
ii) Modular designs of farmers' storage as part of homes with sanitation/hygiene/convenience/ freedom from pests (CFTRI)	2.2 3.6 4.2 4.6 4.9	3 10	Rural Development Dept. of Govt. of India
iii) Survey of tribal food crops and recipes	3.2	3 20	Anthropological Survey, Social Welfa
iv) Hops extraction plant and process (RRL-J)	3.2 3.6	3 20	Industry
v) Utilisation of cassava for industrial and fermentation/ edible purposes (RRL-T)	3.6 4.3 5.1	3 12 20	Ministry of Agriculture, Industry
B. NEW PROPOSALS			
(a) Resource/food augmentation			
i) Design and development of packaging materials, food packages (including structural geometry) and sterilisable pouches, and alternatives to regid/metal based containers (CFTRI)	2.2 2.3 4.1	17	Industry
ii) Design, value engineering and integration of innovative systems for delivery of turn key food technologies (CFTRI)	2.2 3.4 4.9 5.1	20	Ministries State Govts. Industry
iii) Development and utilisation of ocean foods and algae as newer sources of foods and feeds (collaboration with NIO) (CFTRI)	3.6	20	Dept. of Ocean Development
iv) Production of newer plant materials with higher nutritive value: a) Collaborative research with CFTRI on new types of multi-purpose legume, introduction of better varieties of blue-green algae and supplementation of soyabean and other protein/oil bearing crops (NBRI) b) Development of temperate fruits and vegetables in collaboration with CSIR Complex, Palampur.	3.2 3.6	3 10 20	Ministry of Agriculture

1	2	3	4
v) Development and evaluation of special requirements of foods for personnel of ocean going vessels and exploration teams in collaboration with CFTRI & NIO.	3.6 4.9 5.1	20	Dept. of Ocean Development/ Ministry of Defence
vi) Technology for processing high grown low temperature varieties of rice (RRL-J).	3.4 3.6 4.3	3 20	J&K State Government
vii) Improvement in processing coconut and minor oilseeds for convenience foods through viable processes (RRL-T).	3.4	20	Coconut Board, Industry
b) Generation of new energy efficient and cost effective technologies			
i) Application of solar technology for hot and cold storages and evolving new non-refrigerated storage systems (CFTRI).	3.5 3.6 4.6	12	State Govts.
ii) Food process optimisation by application of microprocessors in food processing plants and establishments for achieving increased efficiency (CFTRI).	2.2 3.4 4.9 5.1	20	Industry
iii) Energy budgeting and conservation in food processing and preservation industries by innovative utilisation and recycling of energy sources in cereals/legumes/ oilseeds mills and fruit/vegetable processing plants (CFTRI).	3.5 3.6	3 10	Ministry of Industrial Development, DGTD
iv) Design and fabrication of commercial solar drier (RRL-J).	3.2 3.3 4.9	3 12	Ministry of Agriculture, Small-Scale Industry
c) Post-harvest practices aimed at safe and stable environmental equilibrium			
i) Development of plant insecticides and pollution sensitive plants for integrated protection of environment and pest control by biological agents (CFTRI/TES, RRL-J & RRL-Hyderabad).	2.3	10	Dept. of Environment

1	2	3	4
ii) Microbial control of tea pests for mitigating pesticide residues in tea leaves and made tea (TES/CFTRI).	3.2 3.4	3 10	Plant Prote tion Direct rate
(d) Frontier areas for innovations in post-harvest technology			
i) Post-harvest conservation through metabolic regulation: Methodologies for extended storage life of fruits and vegetables by hybernation/senescence/acceleration of cell biology based on understanding and manipulation of the physiological and biochemical changes in pre-harvest and post-harvest stages (CFTRI).	3.4 4.2	20	ICAR/Hortic ture Depts.
ii) Industrial entomology aimed at developing biological agents for effective pest control, using non-toxic insecticides (semio chemicals), chitinases, pheromones, colour, drugs bioluminiscence and behavioral agents (CFTRI).	2.2 3.6 4.2	3 10 20	Dept. of Ag (Plant Prot ction Direc rate)
iii) Food rheology and formulation (balancing) in relation to fabricated food and analogues to define profiles of newer products from foodgrains, root crops and oilseeds (CFTRI).	2.3 4.2	17	-
iv) Application of tissue culture, recombinant DNA techniques and clonal technology for in vivo production and biosynthesis of fruit flavours, food colours, spice analogues as secondary metabolites (CFTRI).	2.2 4.2 5.1	20	ICAR
v) Development and design of residue free specialised diets to meet strategic needs and therapeutic requirements of space, naval personnel, high altitude, antarctica (CFTRI).	2.2	20	Dept. of Spa Ocean Develo ment, Defenc Ministry, ICMR.
vi) Development of specific diets, prophylactic and inhibitory to vascular and tissue disorders (inclusive of carcinogenic factors) (CFTRI).	2.2 3.6	15	Ministry of Health

1	2	3	4
vii) Tissue culture technology and post-harvest physiology and biochemistry of hill fruits and aromatic plants (Palampur, CSIR Complex).	2.3 3.4	3 20	ICAR, Ministry of Agriculture
viii) Technologies for harvesting and processing of krill from antarctica (NIO).	2.3 3.4 3.6	20	Min. of Agr. Dept. of Ocean Development
ix) Physico-chemical modification of tapioca flour and starch for edible and industrial purposes (RRL-T).	2.3	20	Kerala State Govt.
x) Assay and utilisation of growth promoting and growth inhibiting hormones in tea and their characterisation (TES).	2.3	20	Tea Board
(e) Rural development, employment, generation and welfare			
i) Design and development of kitchen, unit operation and practices forussing attention on efficient energy utilisation, safety, convenience, sanitation and food hygiene in consonance with income and social groups (CFTRI).	3.3 4.2 4.3	12 15	Rural Development Dept. of Govt. of India
ii) Ethnobiological survey of tribals to identify and utilise local resources for integrated raw material utilisation and processing for sources of food, storage, clothing, edible oil, housing, arts and crafts (inter agency).	3.2 3.6 4.3	3 15 20	Min. of Social Welfare, Department of Anthropology

*Key to Technology Policy Statement of Govt. of India

1. Strengthening technology base and inventions (2.3)
2. Rural development and employment generation (3.2)
3. Efficiency and productivity (3.4)
4. Industrial development (3.6)
5. Improving of nutrition (3.6)
6. Energy conserving technologies (3.3)
7. Enhancing traditional skills and technology (4.3)
8. Improving demand for indigenous technology (4.6)
9. Mix of indigenous and imported technologies (5.1)
10. Design engineering (4.9)

*Key to 20-point Programme of Govt. of India

1. Rural development and employment (3)
2. Improved environment (10)
3. Alternative energy sources (12)
4. Welfare of women/children (15)
5. Public distribution system to cater to industrial workers, students' hostels and consumer protection(17)
6. Increasing efficiency, capability utilisation and generation of internal resources (20)

(Figures in brackets conform to those in the documents of TPS & 20-Point Programme of Govt. of India)

C. New Sub-groups for new emerging areas

1. Design, engineering and turn-key food technologies (CFTRI).
2. Conservation through metabolic regulation for extended storage life of food materials (CFTRI)
3. Application of tissue culture/recombinant DNA techniques/clonal technology for in vivo production of flavours/colours/aromatics/spice analogues(CFTRI)
4. Polymer chemistry for functional food package (NCL && CFTRI)
5. Harvesting and processing of exotic food resources from ocean beds, deep sea and antartica regions(NIO)
6. Hydro-cooling and evaporative cooling technology group for designing cold and cool storage (RRL-J).
7. R&D laboratory for low temperature physiology and post-harvest technology for utilisation of resources compatible with high rain fall and high altitude eco-systems (CSIR Centre, Palampur)
8. Cosmetic and toiletory formulae and technologies of their production (RRL-T)
9. Strengthening of Entomology Cells for basic and industrial studies at CFTRI, RRL(H), RRL(J) & NCL.

4.0 MAJOR INFRASTRUCTURE NEEDS

1. Centre for design engineering and transfer of food technologies on turn-key basis.
2. Regional CSIR Centres of application of R&D results to cover:
   a) Palampur CSIR Complex.
   b) Eastern/North Eastern regions, and
   c) Andaman and Nicobar Islands

3. Technological information and liason centres for meeting needs of the industry in Western regions.

4. Centre for food safety monitoring (additives, toxins, pesticides at CFTRI; Toxicology Environment Laboratory (ITRC) and Biological Evaluation Laboratory (RRL-H).

5. Tracer Laboratory for biochemical and metabolic research programmes on foods and additives.

6. CFTRI Centre for application of plant tissue culture in foods and flavours:

   TES Centre - Tissue culture for Tea clones and Tea germ plasm.

7. Flavour laboratory equipped with a flavour library for reconstituting feasible food flavours and studying their diverse regional profiles (CFTRI).

8. Training complex for manpower development in the area of post-harvest technology to meet needs of R&D, industry and rural development programmes.

9. Computer centre for processing scientific/technical information, R&D and institution management.

10. CSIR Centre for low temperature and high altitude crops - Post-harvest research programmes in Palampur, H.P.

11. Workshop for designing prototype tea processing machines at TES.

5.0 FINANCIAL PROJECTION FOR THE AREA OF POST HARVEST TECHNOLOGY

(Rs. Crores)

	85-86	86-87	87-88	88-89	89-90	Total
(a) Continuing Projects						
1. CFTRI, Mysore	3.50	3.50	3.50	2.50	2.00	15.00
2. Tissue Culture (Inter-lab)	0.10	0.10	0.10	0.10	0.10	0.50
3. Polymer/Packaging (Inter-lab)	0.30	0.30	0.20	0.20	0.20	1.20
4. NIO, Goa	0.10	0.10	0.10	0.10	0.10	0.50
5. RRL (Jammu)	0.10	0.10	0.10	0.10	0.10	0.50
6. RRL (Trivandrum)	0.30	0.30	0.20	0.20	0.20	1.20
7. TES,(Tocklai)	0.03	0.03	0.02	0.02	0.02	0.12
8. CSIR Centre (Palampur)	-	-	-	-	-	-
(b) New Projects						
1. CFTRI, Mysore	1.25	2.25	3.25	5.00	6.50	18.25
2. Entomology Cells (Inter-lab)	0.10	0.10	0.10	0.10	0.10	0.50
3. Environment/Toxicology (Inter-lab)	0.20	0.20	0.30	0.30	0.30	1.30
4. NIO (Goa)	0.10	0.10	0.10	0.10	0.10	0.50
5. RRL (Jammu)	0.20	0.20	0.20	0.20	0.20	1.00
6. RRL (Trivandrum)	0.20	0.20	0.30	0.30	0.30	1.30
7. TES (Tocklai)	0.02	0.02	0.03	0.03	0.03	0.13
**8. CSIR Centre (Palampur)	0.05	0.05	0.05	0.05	0.05	0.25
(c) Infrastructure						
1. CFTRI, Mysore	1.25	1.25	1.25	1.50	1.50	6.75
**2. CSIR Centre (Palampur)	0.05	0.05	0.05	0.05	0.05	0.25
Total:	7.85	8.85	9.85	10.85	11.85	49.25

N.B:- Financial projection of CSIR labs is only for POST HARVEST TECHNOLOGY programmes of these laboratories shown in the above statement.

Additional amount of Rs.0.85 crores to be the contribution of the Government of Himachal Pradesh (inclusive of Rs.0.35 crores for outlay on land and Rs.0.50 crores for outlay on staff quarters).

Leather

AREA: LEATHER

Participating Laboratory	Abbreviation
Central Leather Research Institute	CLRI

Contents

		Page
1.0	Review of progress and achievements	31
2.0	Perspectives	35
3.0	S and T Programme for Seventh Plan	37
4.0	Major Infrastructure needs	48
5.0	Financial Projections	50

1.0 REVIEW OF PROGRESS AND ACHIEVEMENTS DURING APRIL 1980 - DECEMBER 1983

A. PHYSICAL OUTPUT INDICATORS

a) Hard output

1. a) Number of technologies in production: (Ten)

Technology for nine types of finished leathers from different raw materials for export and domestic markets and one leather auxiliary.

b) Number of technologies offered/released: (Thirty seven)

Leather: Nine Auxiliaries: Twenty

Machines: Eight design drawings given

c) Products and processes released to industries but not exploited: (Ten)

Leather: Nine
Auxiliaries: Eight
Machines: Two

2. Products and processes that havegone into production: (Fifty)

Leather: Thirty two
Auxiliaries: Twelve
Machines: Six

3. Technologies that have contributed to rural development: (Three)

(i) Improved techniques for curing raw hides and skins; (ii) Improvement of theexisting rural tanning practices and better utilisation of rural tanned

leathers in making finished leathers and leather products; and (iii) Introduction of newer tanning techniques.

4. Technologies that have contributed to social welfare and infrastructure development like sanitation, health improvement, pollution control and water supply: (Four)

5. Technologies that have helped in saving of use of raw materials and/or other inputs: (Two)

6. Technologies for saving energy: Nil

7. Technologies that have gone for improvement of quality and for productivity: (Five)

8. Technology for national security: (One)

9. Nationally important infrastructural facility created: (One)

National Information Centre for Leather and Allied Industries (NICLAI).

b) Soft output (e.g. Publications and Patents)

1. Publications: Scientific papers, technical reports, books and journals

(i)	Scientific papers sent to outside journals ..	55
(ii)	Process bulletins and technical reports ..	14
(iii)	Journals .. (one each in Hindi, Tamil and Urdu; rest in English)	6

2. Papers presented at International Conferences: (Nine)

3. Sponsored projects

a)	Total number taken	..	3
b)	Total value	..	Rs.18.45 lakhs
c)	Number completed	..	2
d)	Development of design drawings for (i) tanning, (ii) leathergoods, and (iii) footwear machinery (not completed).		

4. Services provided indicators

Consultancy services rendered

(i)	Feasibility reports	..	12
(ii)	Literature survey	..	8
(iii)	Design Engineering	..	4
(iv)	Erection/Commissioning of plants		1
(v)	Assessment of Corporate R & D Programme of the client	..	3
(vi)	Analysis, interpretation and validation of test results		1756
(vii)	Trouble-shooting and assistance		315
(viii)	General consultancy and advice		1420

5. Financial flow/Earnings indicators

(i)	Cash flow from sponsored projects	Rs..8.453 lakhs	
(ii)	Cash flow from consultancy royalty, premia, analytical and testing services, and publications	Rs.20.507	"
(iii)	External funding for project/ facilities not falling under (i)	Rs.38.865	"
(iv)	Value of production as a result of exploitation of products/processes developed by the labs.	Rs.16.400	"

6. Education and training indicators

Training courses organised

(i) Course conducted jointly with Universities

B.Tech.; 5 years; 85
M.Tech.; 2 years; 12

(ii) Short term training courses for the industry

Course in leather manufacture; 3 months; 94; Rs.1.128 lakhs (9 such courses have been conducted).

(iii) Special courses: Four

(iv) Foreign Trainees; Duration varies from 1 to 8 months; 18; Rs.0.360 lakhs.

2.0 PERSPECTIVES

a) National Needs

The Indian Leather Industry is now undergoing a transition from the stage of mainly producing and exporting finished leathers to the stage of producing and exporting finished leather products. While promoting this transition, it is imperative to ensure that the available raw material resources are fully and effectively utilised, leading to the maximum possible returns. This transition will lead to generation of greater employment in all the sectors starting from the rural sector. This in turn will lead to raisingthe living conditions of the weaker sections of the society and women. While hitherto leather has been a commodity of export significance, with theshift to making of leather products, the internal marketfor finished leathers has increased tremendously. The domestic market for the leather products also is increasing due to increased standards of living.

For the second transition to be effective and complete, the industry needs to have design development capability, simple tools that can be operated by the small entrepreneurs, trained personnel at various levels, an optimum degree of mechanisation and the right type of starting and ancillary materials. In order to supply the leather products industry with the required type of leathers, the leather producing units need to have the appropriate raw materials, auxiliaries and machines and needless to say trained manpower.

While the country has to become self-sufficient for the right type of leather auxiliaries that go into the production of present-day high quality finished leathers, the necessary technology base has to be available within the country for this. While developing this technology base, it is equally necessary to have newer types of auxiliaries based on non-traditional starting materials so as to impart precise characteristics desired in the finishedleathers. The pollution problem is looming very large and effective steps have to be taken for treatment and disposal of effluents and also prevention of pollution.

b) International Trends

The developed countriesin the West, who were originally buyers of semi-finished leathers are now prepared to accept finished leathers as well as finished leather products, but to strict specifications. The leather and leather products industries in the developed countries are able to call upon the prompt and ready services of the chemical and the machine industries, who are always supplying them better and better processing materials and machines. Also the Western countries are the creators of fashion and naturally they are able to dictate and control the development of the leather and allied industries in the developing countries. They are making the market highly competitive by entering into tie-ups in some of the developing countries like Korea, Taiwan and Hong Kong. To these countries they supply the required materials and machines at competitive rates and are able to keep the cost structure down by utilising the low cost labour in these places. India with its adequate resource base, institutional backing, R and D and training can hopefully capture a sizeable slice of the market for the high value added leather products.

3.0 S & T PROGRAMME FOR SEVENTH PLAN

The programme of CLRI has to be directed to make the Indian Leather and allied industries stand up to the stiff competition from the other developing countries and capture the markets by marketing commodities meeting the specific requirements. While development of the technology for different kinds of leathers is a continuous effort, this has to be adjusted to suit the specific requirements prevailing at a specific time. In the case of auxiliaries, it is advantageous to shift the emphasis from developing the know-how for routine auxiliaries to sophisticated auxiliaries which play an important role in determining the ultimate quality of the finished leathers. Even here, newer types of starting materials have to be explored so as to give rise to newer and more efficient leather auxiliaries. While leather research hitherto has been on leather per se, the research has to be now redirected to evolving leather suitable for the end use, namely for making footwear, garments, leathergoods, sports goods, etc. Standardisation of materials and processes also is an important aspect. It is necessary now to raise leather science to a level whereby it is possible to obtain a material of the required type by tailoring the techniques and materials suitably. For this, a good store of basic knowledge from the material science point of view has to be built up.

The sources of raw material supply, whether hides or skins, are inelastic; the raw materials are themselves by-products of another industry. The counry is not able to derive the maximum returns from the available raw materials because of the greater incidence of lower grades and rejections. The imperative need is to upgrade

these by suitable techniques or by blending them with other natural fibre materials. The programme of CLRI for the Seventh Five Year Plan period looks to all these aspects.

The essential features of the programme proposed are as follows:

(i) Expansion of existing facilities in the tannery and theregional centres and scaling up.

(ii) Creation of new facilities in the leather goods and footwear sub-areas

(iii) Centralised Instrumentation Cell

(iv) Setting up of model tannery effluent treatment plants at different scales.

.o.

LABORATORY PROGRAMME (Sub-area-wise)

Sub-Area: Leather Goods

a) Continuing projects

i) Title: Design development and fabrication of leather goods

Objective: To evolve functionally better designs and fabrication techniques for leather goods and puppets.

Output/ Impact: The various parameters figuring in design development will be studied. The results of the studies will reach the industry in the form of newer designs and techniques enabling it to develop its domestic and external markets.

ii) Title: Design development of tools and simple machines for leathergoods fabrication

Objective: To develop tools and machines to improve the quality of products and efficiency and productivity in production.

Output/ Impact: The expected outputs are tools and machines (not employing power), eliminating drudgery in the various operations, especially the repetitive ones, in leathergoods making, suitable for cottage and small scale sector units. The industry will be able to increase its productivity without large scale mechanisation and thus generate greater employment potential.

b) New proposals

i) Title: Development of materials for leather goods (CLRI will guide other concerned agencies)

Objective: To carry out a systematic study on the properties and utility of the currently used materials of the components used in leather goods making, e.g., the leather material, lining, foundation, adhesive, fittings and also newer materials.

Output/ Impact: The studies would lead to making available to the leathergoods industry, materials, which are amenable to the fabrication techniques and impart desired characteristics in the final product.

ii) Title: Studies on methods of production of leathergoods

Objective: To evolve suitable techniques for the fabrication for the different types of leathergoods.

Output/ Impact: Fabrication techniques involving the optimum material inputs in relation to the cost structure are expected to result from these studies specifically for the cottage and small scale units.

iii) Title: Evolving test procedures for leathergoods

Objective: To evolve standard procedures and norms for testing the leathergoods and to design and develop instruments and equipment for carrying out the tests.

Output/ Impact: This work would result in formulation of the required methods for testing and evaluation so essential in ensuring the quality of the final product in respect of its functional durability and thus meet the stringent requirements of the foreign market.

iv) Title: Development of design and fabrication techniques for leather garments and gloves.

Objective: To create an indigenous design base for the leather garments industry.

Output/ Impact: This will fill up the gaps currently existing in respect of designing and fabricating leather garments and will provide efficient backup service to the training programme in respect of leather garments.

v) Title: Studies on fabrication of sports goods

Objective: To provide efficient evaluation of the sports goods leathers and to develop alternative techniques in the making of the different types of sports goods.

Output/ Impact: The work proposed will lead to the creation of a sound technological base for the leather based sports goods industry. By this the industry will be able to develop its capability in competing in the international market.

Sub-Area: Footwear

a) Continuing projects

i) Title: Studies of the factors contributing to footwear comfort

Objective: To arrive at the optimum parameters leading to the maximum confort in footwear.

Output/ Impact: The work in this project will lead to a collection of basic data for being utilised in the designing of footwear for different climatic conditions, with respect to the different design parameters.

b) New proposal

i) Title: Footwear Research, Design and Development Centre

Objective: To serve the footwear industry in a comprehensive way by development of designs and improved methods of fabrication, evaluation and testing of the footwear materials, providing testing and training facilities.

Output/ Impact: There is no such set up at present for the footwear industry, 80 percent of which exists in the small scale sector. The creation of such a centre will enable the industry to develop design capabilities; it will catalyse the development of the industry to the stage of exporting fully fabricated shoes.

ub-Area: Finished Leathers

) Continuing projects

i) Title: Developing processes for different types of leathers, like upper, lining, sole, garment and sports goods leathers, from both indigenous and imported raw materials for the export as well as domestic markets

Objective: To provide the Indian tanner with the know-how required in meeting the continually varying requirements of the overseas buyer and also for catering to the increasing demands of the Indian leathergoods and footwear industries.

Output/ Impact: This is a continuous task. The market requirements keep changing from time to in accordance with fashion trends and the R and D work in view will provide the industry with the processes needed in catering to these trends.

ii) Title: Development of special types of auxiliaries required in making sophisticated finished leathers and leather products.

Objective: To generate know-how for the range of auxiliaries that go into production of sophisticated leathers and leather products.

Output/ Impact: Production of high quality finished leathers is greatly dependent on the leather auxiliaries inputs. This ia a front, wherein advances are made continuously and work has to be done continuously. This will result in generation of the required know-how for making sophisticated auxiliaries like syntans, tanningagents and adhesives, shoe finishes and dressings. Special attention will be given to developing less toxic materials.

iii) Title: To study the inter-relationships between composition of fat liquors and the properties of finishedleathers.

Objective: To formulate fat liquors which impart the required characteristics, when applied in smaller dosages.

Output/ Impact: The studies will lead to formulation of fatliquors which predominantly consist of constituents getting permanently fixed to the hide substance. Such fatliquors give better leather.

iv) Title: To develop processing techniques with in-built capability for prevention of damage due to microbes and similar agents.

Objective: To avoid the incorporation of separate preventive agents.

Output/ Impact: The preventive agents currently used are toxic and have to be separately incorporated. The modification of techniques as indicated would make the leather itself proof to such damage and also cut down the additional cost.

b) New proposals

i) Title: Leather making techniques with better water management

Objective: To evolve processes which consume less water and are amenable to reuse of water and also ensure near complete uptake of tanning and post-tanning chemicals.

Output/ Impact: Current techniques consume large quantities of water. By reducing the quantities, the effluent volume and the cost of effluent treatment will be lessened. By ensuring complete exhaustion in the processing liquods, the pollution load also will be lessened.

ii) Title: Newer types of auxiliaries prepared from materials other than those traditionally employed.

Objective: To develop products with improved efficiency and less toxicity and pollution

Output/ Impact: The know-how generated hitherto and the types of auxiliaries prepared indigenously are based on traditional starting materials. Using alternative starting materials, the specific effects required in finished leather can be achieved and the pollution inherent in the existing materials can be avoided (for example syntans based on sulphone are effective in producing white colour).

iii) Title: To study the quantitative inter-relationships between the processing materials and the effects produced by them in the final leather.

Objective: To establish correlations which enable the tailoring of the leather making process so as to give a finished product with a desired set of characteristics.

Output/ Impact: Present practices are based on empirical knowledge. As in the field of dyes and pharmaceuticals inter-relationships between chemical structure and properties are to be derived. Using these, formulations will be worked out which will impart the desired characteristics in the required magnitude.

iv) Title: To evolve measurement techniques to replace the currently used subjective methods of assessment.

Objective: To rationalize the measurement of the intangible properties of leathers.

Output/ Impact: The evaluation of leathers continue to be subjective. Suitable mathematical models will be derived for the various properties and instrumental methods of measurement and assessment will be formulated.

v) Title: Biodegradable biocides for preservation of raw hides and skins.

Objective: To develop preserving agents which do not add to the pollution load and toxicity.

Output/ Impact: Salt, the material in vogue, is a major pollutant. This will be replaced by a material which can be degraded and so will not add to the pollution load.

Sub-Area: Regional Centres for Development

a) Continuing projects

i) Extension Services: The current services like practical demonstrations, consultancy, trouble shooting, technical services will be continued.

b) New proposal

Self-contained R & D Units: The existing regional centres will be expanded in their strength and facilities so as to carry out R & D and generate the technical know-how required to cater to the special needs of the different regions, in regard to leather, leather products and byproduct utilization and also to render technical services on an expanded scale and to provide training facilities. The regional units will devote special attention to the rural level industry.

(The work relating to Jalandhar and Calcutta centres has proceeded. The work relating to the other centres is to be taken up.)

Sub-Area: Byproducts

a) Continuing project

Title: Preparation, testing and evaluation of:
a) protein meals for livestock feed,
b) isinglass for use in breweries,
c) heparin for medical use, and (d) collagen based products for use in surgery, food and cosmetics.

Objective: To utilise to the maximum extent possible the slaughter-house animal byproducts

Output/Impact: The slaughter-house animal byproducts are currently largely going to waste. Using the newly set up pilot plant the profitable avenues for exploitation will be demonstrated. Emphasis will be given to the sub-item (d) in the title.

Sub-Area: Training Programmes

a) Continuing

Title: Imparting training at various levels (i) Graduate and Post-graduate levels in Leather Technology; (ii) Short-term training courses in Leather Technology; (iii) One year training course in Leather-goods and (iv) Refresher courses.

Output/Impact: The industry's needs of trained technical personnel will be met.

b) New

Title: Advanced Industrial Training Centre for the Indian Leather Garment Industry.

Output/Impact: The developing leather garment industry will be supplied with the required trained personnel.

Sub-Area: Fur

a) Continuing

Title: Processing of sheep and goat and fur skins into shearlings, suedes and finished furs.

Objective: To develop processes which are economical and avoid pollution

Output/Impact: Profitable outlets will be obtained for the furs produced.

4.0 MAJOR INFRASTRUCTURE NEEDS

Title: Instrumentation and Analytical Services Centre (including the computer)

Objective: To centralise all the instrumentation and analytical facilities and render the required services to the various R and D areas.

Output/Impact: The proposed set-up will bring together the facilities, render maintenance easy and will avoid unnecessary replication of facilities. It facilitates more efficient service.

5. FINANCIAL PROJECTION

I. LEATHER AREA: (Except for the sub-area 'FUR' the participating laboratory for the other areas is only CLRI)

(Rs. in lakhs)

	1985-86	1986-87	1987-88	1988-89	1989-90	Total	
Sub-Area: LEATHERGOODS							
Continuing	33.75	26.25	19.10	18.20	19.00	116.30	
New	6.00	6.00	5.00	4.00	4.00	25.00	141.30
Sub-Area: FOOTWEAR							
Continuing	13.00	10.00	8.00	9.00	10.00	50.00	
New	19.50	34.75	40.00	34.50	29.50	158.25	208.25
Sub-Area: FINISHED LEATHERS							
Continuing	30.00	39.70	28.25	11.75	13.30	123.00	
New	9.00	10.50	22.40	24.30	19.80	86.00	
Infrastructure (New)	16.50	22.50	23.75	7.50	5.00	75.25	284.25
Sub-Area: REGIONAL CENTRES FOR DEVELOPMENT							
Continuing	54.00	59.00	68.00	78.00	82.00	341.00	
New	130.00	170.00	156.00	115.50	118.50	690.00	1031.00
Sub-Area: BYPRODUCTS							
Continuing	10.25	7.10	7.30	8.00	9.35	42.00	
New	4.00	5.50	5.65	6.55	7.30	29.00	71.00

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	1985-86	1986-87	1987-88	1988-89	1989-90	Total	
Sub-Area: FURS AND SUEDES							
(Participating Laboratory: R.R.L., Jammu)							
New	10.00	10.70	11.45	12.25	13.10	57.50	57.50
Sub-Area: TRAINING PROGRAMME							
Continuing	7.00	6.75	6.50	8.00	8.50	36.75	
New	4.00	4.75	5.75	7.00	8.00	29.50	66.25
Consolidated sub-total of financial projections for continuing & new projects							
Continuing	148.00	148.80	137.15	132.95	142.15	709.05	
New	182.50	242.20	246.25	204.10	200.20	1075.25	
	330.50	391.00	383.40	337.05	342.35	1784.30	
III. Infrastructure for the Area							
New	59.50	183.50	53.75	24.50	22.50	343.75	
Total I + III	390.00	574.00	437.15	361.55	364.85	2127.55	
Infrastructure: Existing	114.55	149.20	145.85	148.50	144.45	702.55	
GRAND TOTAL	504.55	723.20	583.00	510.05	509.30	2830.10	

Natural Products (Cultivation and Processing etc.)

AREA : NATURAL PRODUCTS - CULTIVATION AND PROCESSING

Participating Laboratories

- Central Institute of Medicinal and Aromatic Plants, Lucknow — CIMAP
- Central Salt & Marine Chemicals Research Institute, Bhavnagar — CSMCRI
- National Botanical Research Institute, Lucknow — NBRI
- Regional Research Laboratory, Jammu — RRL, Jammu
- Regional Research Laboratory, Jorhat — RRL, Jorhat
- Regional Research Laboratory, Bhubaneswar — RRL, Bhubaneswar

Contents

		Page
1.0	Achievements	54
2.0	Perspectives	66
3.0	Programme	68
4.0	Financial Projections	73

1.0 ACHIEVEMENTS

1.1 PHYSICAL OUTPUT INDICATORS

1.1.1 HARD OUTPUT

1.1.1.1 Number of technologies in production

CIMAP	..	23
CSMCRI	..	2
Total	..	25

a) Agrotechnologies (21 Nos.)

CIMAP

Japanese mint, peppermint, bergamot mint, citronella java, palmarosa, linaloe, geranium, davana, French basil, patchouli, hops, Bulgarian coriander, ergot, belladonna, pyrethrum, Ammi majus, periwinkle, Eucalyptus citriodora, Rauwolfia serpentina, lemongrass and lavender.

b) Processing technologies (4 Nos.)

CIMAP	...	2
CSMCRI	...	2
Total		4

CIMAP : Diosgenin from rhizomes of Dioscorea deltoidea and menthol from Mentha arvensis oil

CSMCRI : Manufacture of alginate and manufacture of agar.

1.1.1.2 Number of technologies offered/released

CIMAP	...	3
CSMCRI	...	4
Total		7

TITLES

CIMAP

a) Process for production of Cyperus scariosus

b) Modern distillation technology for rose oil production

c) Cultivation and processing of Duboisia

CSMCRI

Jojoba cultivation, Guayule cultivation, Juncus cultivation and Atriplex cultivation.

1.1.1.3 Technologies that have gone for rural development

a) CIMAP 26 (Kindly see 1.1.1.1 and 1.1.1.2)

b) RRL, Jorhat 6

Total : 32

1.1.1.4 Technologies that have helped in saving of use of raw materials and/or other inputs

CSMCRI : Cultivation of sea-weeds

1.1.1.5 Technologies that have gone for improvement of quality and for productivity

Total ... 4

RRL, Jorhat (2 Nos.)

a) Development of new strain of Java citronella, designated as Jor Lab C-2

b) Agrotechnology on Dioscorea composita

CIMAP (2 Nos.)

a) Development of superior strain of peppermint
b) Development of superior strain of spearming

1.1.1.6 Technologies for resource exploration/exploitation

Total ... 2

CSMCRI

a) Exploitation of coastal sand dunes, saline and waste lands for cultivation of economic plants like jojoba, guayule, juncus, Atriplex, etc.

b) Reports on seaweed resources and coastal area of Gujarat, Maharashtra, Tamil Nadu and Lakshadweep.

1.1.1.7 Nationally important infrastructural facilities generated for different R & D areas

CIMAP : Two sophisticated instruments, i.e., ^{13}C NMR spectrophotometer and Electron microscope with scanning attachment have been installed.

CSMCRI : FT-NMR facilities.

1.1.2 SOFT OUTPUT

1.1.2.1 Major R & D achievements in different areas of R&D

1.1.2.1.1 Basic Research

CIMAP, Lucknow

a) Agronomy & Soil Science : Based on the experiments on relative efficiency of urea and ureasupergranules in Java citronella it was evident that a large amount of nitrogen fertilizer could be saved through the use of urea supergranules. Another experi ent carried out in the same crop indicate that placement of urea at 5 cm depth reduced ammonia

volatilization losses considerably whereas placement of urea-supergranules and sulphur coated urea at 5 cm depth almost eliminated the losses.

b) Genetics and Plant Breeding : In Costus speciosus, self-incompatibility was noted.

In various collections of vetiver, chromosome morphology, total haploid complement, chromatin length and DNA content have been worked out. Besides, chromosomal instability in lemongrass was recognised for the first time.

c) Plant Physiology and Biochemistry

Studies revealed that deficiency of micro-nutrients like Cu and Fe influences the oil content and quality in citronella Java. Similar studies were also made in lemongrass and Japanese mint. In case of opium poppy, boron requirement is quite high.

Studies on the effect of various plant growth substances on citronella Java were also undertaken. In Costus speciosus, kinetic and IAA stimulate sprouting significantly and increase tuber yield.

d) Botany & Pharmacognosy including economic survey

Ethno-medico-botanical survey of various areas of M.P., U.P., Himalayas, Himachal Pradesh and J & K was undertaken. Certain well-known medicinal plants were collected.

Pharmacognostic studies on 'Brahmi' (Bacopa moninniera Wettst.) and Solanum sp. have been completed so as to identify these from adulterated samples.

e) Plant Pathology : Studies revealed isolation of Aspergillus tamarii Kita and three other species of Aspergillus from Kodo seeds (Paspalum scrobiculatum L.) which produce ergot alkaloids.

Causal organisms of downy mildew, soft rot and capsule rot in opium poppy were identified. Similar studies were carried out in lemongrass, citronella Java and Catharanthus roseus. The experiments were also carried out on the study of physiology of Phytophthora nicotianae causing leaf blight of Costus speciosus, Alternaria alternata causing leaf blight of Egyptian and black henbane and Curvularia sp. causing a new leaf spot disease in rose (Rosa damascona).

RRL, Jammu

Various medicinal plants from natural resources were evaluated quantitatively and qualitatively and techno-economic studies were carried out. Such plants are Costus speciosus rihizome as a source of diosgenin, Silybum marianum seed as a source of sylibine and other antihipatotoxic compounds, Allium sativum bulb as a source of garlic oil, Archangelica officinalis rhizome as a source of angelica oil and Boswellia serrata oleogum resin as a source of anti-arthritic compounds.

The work led to the development of resources and standardisation of these plant products as commercial raw materials for the first time in India.

RRL, Jorhat

Insect control agents from Tricholepis glaberima, Grangea madaraspatana and Sorchus arvensis were developed.

Plant resource survey in North East rn region has identified potential medicinal and economic plants like Dichroa sp., Lindera neesiana, etc.

RRL, Bhubaneswar

Plant survey of Ganjam district has been completed.

CSMCRI, Bhavnagar

Phytosalinity : Sea water tolerant variety of crop plants grown and work on salt tolerance of Prosopis and effect of salt laden wind on Casuariana were completed successfully.

Marine Algae : Boisaline research was taken up in India. Regeneration and recolonisation studies on Sargassum wightii were carried out.

1.1.2.1.2 Applied Research

a) Genetics and Plant Breeding: A high oil containing (0.8-1.0%) and menthol-rich (82-85%) strain of Japanese mint was developed from a natural bud-sport isolated from a Thai strain.

India's menthol industry has been facing a serious crisis because of genetic deterioration of local strain of Japanese mint, resulting into decrease in menthol content (58-60%) with more than 20% menthone. Introduction of newly developed strain in the farmers field would increase per hectare yield of menthol at reduced cost of production enabling Indian manufacturers to enter the export market.

A new strain of Mentha piperita, yielding 30-35% more herb and adopted to subtropical climate, erect in habit and resistant to insects-pests was evolved. Similarly a high oil containing strain of spearmint was developed. Both these strains were released for cultivation by farmers. In addition, superior strain of opium poppy,

pyrethrum, lemongrass, citronella and Hyoscyamus niger were evolved which will give better return to a farmer.

b) Chemical Engineering: A modern technology for rose oil production was developed giving recovery of 0.03% oil which is slightly higher than that obtained in Bulgaria and more than four times the oil obtained with the use of country-made stills. The technology has been purchased by Agra Vikas Nigam who would put up a commercial plant.

An improved technology developed for distillation of vetiver roots yields 0.20% to 0.25% oil as compared to the poor yield of 0.06% to 0.10% being obtained using country-made stills.

c) Agronomy and Soil Science: Two exotic plants, i.e., Hyoscyamus muticus and Duboisia myoporoides were introduced and agrotechnologies for commercial plantation have been developed. These are the important sources of tropane alkaloids in the world.

Investigations in ergot revealed that two consecutive crops of ergot could be obtained from the same piece of land in a year at Kodaikanal unlike temperature areas of India like Kashmir Valley and the European countries where only one crop can be taken.

Lavender and clary sage have been successfully introduced in Kashmir Valley. These can be grown in marginal and poor lands where no irrigation facilities are available. Both these oils are being imported to meet the requirements of the country.

Optimum fertilizer requirement in various economically important medicinal and aromatic crop has been found out.

d) Plant Pathology: Ergokryptine and ergometrine rich strains of ergot were developed which are superior to the strains available in the other parts of world.

Both the drugs and its derivatives are pharmaceutically important. Ergokryptine is imported in India today at an exhorbitant price. Commercial cultivation of this strain would go a long way in stopping its import from abroad.

RRL, Bhubaneswar

The Laboratory has developed two high yielding strains of palmarosa and one strain of Solanum viarum and released to industries.

Agrotechnologies for cinnamon, citronella, palmarosa and Solanum viarum were developed.

RRL, Jammu

Two new aromatic plants, i.e., Clocimum and Jamrosa have been introduced and their oils have been commercially accepted by the industry. Clocimum is the source of eugenol, whereas jamrosa is the source of geraniol. Eugenol is an important raw material which is imported. Distillation practices for these plants have also been standardised and process for isolation of eugenol from Clocimum and geraniol from Jamrosa oil have also been developed.

Pure strains of Ocimum sp., rich in methyl chavicol (70%), have been developed. Oil has been evaluated by the industry.

Two exotic plant species, i.e., Eucalyptus macroryncha and E. youmanii, rich in rutin, were introduced in Palampur and their agrotechnologies have been developed. The tea estates in H.P. have taken up the cultivation.

Hops were produced in Kashmir Valley in 1982, total hop produced crossed 1.5 crores mark. The country has attained self-sufficiency in the item.

The post-harvest technology for processing a-acid rich hops extract and hops oil has been perfected.

RRL, Jorhat

Know-how on cultivation, distillation and processing of lemongrass, Eucalyptus citriodora, Mentha piperita, Java citronella, Ocimum gratissimum, Dioscorea composita and D. floribunda were developed under North Eastern climatic conditions.

CSMCRI, Bhavnagar

Phytosalinity : Investigations were carried out on developing air-layering technique for Avicennia and halophytes, successfully introduced Atriplex species and growing at sea-rush grass. Nursery technique for large scale cultivation of jojoba and Guayule were evolved.

Marine Algae: Two processes were developed for cultivation of Enteromorpha, the potential algae for protein and drug. In addition, cultivation of economically important plants on sand dunes and sea-water irrigation studies were taken up.

From Brown green algae, Sargassum, a process has been developed to manufacture liquid sea weed fertilizer. A technique for preparation of sea weed meal from Gracilaria sp. has been developed.

Development of a method for preservation of seaweed has also been achieved.

National Botanical Research Institute

Introduction and improvement of ornamental plants

Nearly 250 species of orgamental plants were introduced and several of them are of admirable beauty. Plants like Erythrina resupinata have been domesticated.

Genetic improvement of economic plants

The amino-acid composition of seed proteins of six varieties of Amaranthus hypochondriacus were determined. The black seeded flora (AG-16) had higher protein but the cultivated form had more lysine. Varieties AG-16 and AG-21 may be particularly useful in yielding some transagressive segregates for high proteins as well as aminoacids.

Higher yielders of guar have been indentified.

A field survey on reproductive biology of Indian connifer forests, particularly Pinus, Cedrus, Abies, Picea and Cupressus species of Himalayas for application and development of Indian forestry through genetic improvement was completed.

A promising cultivar of opium-poppy, named NBG-1, was identified.

1.1.2.2 Publications

	Scientific papers	Technical papers	Books	Journals	Papers presented at International conferences
CIMAP	92	2	6 (Farm Bulletin)	1 (House journal)	12
NBRI	166	-	-	-	7
RRL, Jorhat	45	14	-	-	-
CSMCRI	58	3	-	-	2
	361	19	6	1	21

1.1.2.3 Patents filed and sealed

CIMAP : Filed - 2
NBRI : Seven new cultivars registered
CSMCRI : Filed one; sealed one

1.1.2.4 Surveys

CIMAP : 4 (Medicinal and aromatic plants resources)
CSMCRI : 2
Total : 6

1.2 Sponsored Projects

	Total No. taken up	Total amount (Rs. in lakhs)	No. completed
RRL, Bhubaneswar	1	0.30	-
RRL, Jorhat	1	5.00	1
CSMCRI	6	19.65	4
Total:	8	24.95	5

Titles of the Projects costing more than Rs.10 lakhs

CSMCRI

1. Aquaculture of Enteromorpha sp. by DST
2. Evaluation of salt tolerant of Prosopis
3. Effect of salt laden wind on Causarina equisetifolia
4. Grant-in-Aid project on Guayule
5. DST-Sponsored on adoptation trials of Guayule in different Agro-climatic zone
6. All India Coordinated Project on Algae sponsored by DST.

1.3 SERVICES PROVIDED INDICATORS

1.3.1 Statutory Services

CSMCRI : 1 (Testing of water for its biological potatability)

1.3.2.1 Consultancy Services

	Feasibility reports	Literature survey	Erection/ commissioning of plants	Trouble shooting and assistance	General consultancy and advice
CIMAP	-	1	2	-	7
NBRI	-	-	-	-	1
RRL, Bhubaneswar	15	-	-	-	-
RRL, Jorhat	5	-	-	25	-
CSMCRI	-	-	-	-	1
Total :	20	1	2	25	9

1.4.0. FINANCIAL FLOWS/EARNING INDICATORS

1.4.1 Cash flow from sponsored projects (Rs. in lakhs)

RRL, Bhubaneswar	0.30
RRL, Jorhat	5.00
CSMCRI	24.57
Total :	29.87

1.4.2 Cash flow from consultancy etc. (Rs. in lakhs)

	Consultancy	Analysis and testing	Publications
CIMAP	0.747	0.185	0.488
RRL, Bhubaneswar	1.280	-	-
	2.027	0.185	0.488

1.4.3 Value of production as a result of exploitation of products and processes

	(Rs. in lakhs)
CIMAP	3,218
RRL, Jorhat	1,000
	4,218

1.5.0 EDUCATION AND TRAINING INDICATORS

1.5.1 Training courses organised and No. of persons trained

	Internal	External	Fee received (Rs.)
CIMAP	3	2	9,310 (External)
RRL, Jorhat	41	-	-
	44	2	9,310

2.0 PERSPECTIVE

Medicinal and aromatic plants have attained a considerable importance both in developed and developing countries. It has now been realised that indiscriminate use of synthetic drugs and antibiotics leads to considerable toxicity and bad side effects specially in cases of common ailments. In addition, micro-organisms are also reported to develop resistance to certain synthetic drugs. However, the drugs derived from plants are being considered safe both in poor and affluent countries and as such their use has increased considerably throughout the world during the last few years. A similar situation has arisen in case of perfumery, flavour and cosmetic industries where toxicity associated with the synthetics and increase in price of petroleum products have forced the manufacturers throughout the world to look for both safe and effective herbal preparations wherein essential oil-bearing plants play a major role.

During the last few years, CIMAP and its sister laboratories have successfully introduced exotic plants, developed agrotechnologies and processing technologies so as to make the country self-sufficient in major medicinal and essential oil-bearing plants. However, due to less stress on basic science for improvement of cultivation and processing technologies, the yields of these crops either have been much lower as compared to other countries or the yields increased marginally. As such, our cost of production has been higher as compared to other major producing countries and we could not compete in the world market because of our higher prices. It is, therefore, imperative to employ basic scientific investigations in the area of genetics, tissue culture, plant

breeding and agronomy to achieve a breakthrough in higher yields at much cheaper costs. This will enable India to enter into export market, increase job prospects in rural areas coupled with increase in the cash income to poor farmers. It is, therefore, proposed to intensify research on physiological and biochemical aspects of such plants, study of nutritional requirements using radio-active tracer technique, water-management studies, use of modern methods of tissue-culture chromosomal and genetic manipulation to evolve high-yielding varieties and genetic manipulation to evolve high-yielding varieties resistant to insects and pests and strengthening of CIMAP Regional Centres.

It is also proposed to introduce improved varieties of medicinal and aromatic plants in the country and take up cultivation of those medicinal and aromatic plants which are still being imported, e.g., Glycerrhiza glabra, lavender oil, patchouli oil etc.

Survey of natural resources in the country in respect of medicinal and aromatic plants needs intensification so that new plants for drugs and perfumery are identified. This programme should be undertaken in collaboration with Botanical Survey of India.

3. PROGRAMME

3.1 Ongoing Projects

	C I M A P
i. Development of improved agrotechnologies for some of the aromatic grasses, *Chrysanthemum cinerariaefolium*, *Lavandula* species, important *Mentha* species, *Papaver somniferum*, *Pelargonium graveolens*, *Rosa* species, sapogenin-bearing plants and *Catharanthus roseus*	Improved agrotechnologies will be developed for increased production
ii. Development of agrotechnologies for *Salvia sclarea* and tropane alkaloids-containing plants	Agrotechnologies for these plants are lacking; hence these will be developed
iii. Development of improved technologies for a) production of ergot and ergot alkaloids b) processing of essential oils and oleoresins c) *Catharanthus roseus*	Increased production of dr aromatic chemicals and ole resins
iv. Screening of aromatic flora/ medicinal plants for new sources of essential oils/steroids, alkaloids	New sources of essential o oleoresins, steroids, alka loids will be developed
v. Pharmacognostic studies of some of the important crude drugs	For identification of crud drugs and their adulterant
vi. Ethno-medico-botanical survey of various areas in India	Identification of plants b ing used as folklore medi cines and their exploitati
	N B R I
vii. Introduction and acclimatization of non-traditional economic and rare ornamental plants	Production of economic and ornamental plants
viii. Improvement, production and standardisation of agrotechnologies of ornamental plants for nursery and cut-flower trade	Increased productivity
ix. Genetic upgrading and agrobotanical studies of under-exploited, subsidiary foods: *Amaranthus* protein-rich grain and carotene-rich pot herb	Increased productivity

x. Utilization of guar seeds	Development of a variety for high gum content
xi. Reproductive biology and natural variability in Indian soft woods (Collaboration with forest departments and universities)	Genetic improvement of conifer trees for increased productivity
xii. Breeding opium poppy for higher morphine/codiene content	Increased productivity
xiii. Taxonomic and morphological studies of plants	Identification of plants
xiv. Endangered and threatened pteridophytes of India and their conservation	Conservation
xv. Usar land reclamation and utilisation at Aligarh	Utilisation of usar land for economic plants
xvi. Integrated study of energy flow, nutrient cycling and hydrological cycling in ecosystem developed by marginal soils	Utilisation and improvement of marginal land for biomass production
	RRL, Bhubaneswar
xvii. Agrotechnology and improvement of Dioscorea floribunda and cinnamon and extension of work on aromatic, medicinal and economic plants	Increased production
xviii. Extension of cultivation of medicinal and aromatic plants for rural development	Production of medicinal plants, essential oils in rural sector for making the country self sufficient in these items and making the economy of rural people stronger
	RRL, Jammu
xix. Continuation of down-stream products of hops	Increased production through breeding, plant protection, improved agrotechniques and post-harvest technologies
xx. Resource survey of plant-based raw materials	Identification of new raw material
xxi. Genetic improvement of medicinal and aromatic plants	To evolve superior strains for increased production

	RRL, Jorhat
xxii. Survey, introduction, cultivation, improvement and processing of medicinal, aromatic and economic plants of north-eastern region	Survey of area of new sources for medicinal and aromatic plants, introductions of potential medicinal and aromatic plants for the region, development of improved strains for economic yield
	CSMCRI
xxiii. Cultivation of jojoba (Multilocational Coordinated Project)	Utilisation of coastal dun sand and saline soil and production of liquid wax
xxiv. Multi-locational adaptibility trials of guayule in semi-arid regions (DST Project)	Utilisation of waste land and extraction of resin and rubber
xxv. Utilisation of waste land, development and extension activity of jojoba, guayule and also other economic plants (Multi-locational Coordinated Project)	Use of waste land for economic plants
xxvi. Studies on halophytes and their uses	Utilisation of saline/ marshy land, use of salt tolerant plant species for biological desalinatio and for paper pulp and other products
xxvii. Utilisation of marine algae, their biological studies, cultivation, introduction of exotics etc.	Preparation of iodine fortified food additives from suitable algal specie

3.2 New Projects

Titles	Objectives and End Results
	CIMAP
i. Improvement of medicinal and aromatic plants through chromosome and genetic engineering	To produce superior clones for better returns
ii. Setting up of water-management laboratory	To find out water requirements of medicinal and aromatic plants for optimum yield

iii. Research on medicinal and aromatic crops for saline/ alkaline soils and saline/ sodic water irrigated areas	To make use of such land for medicinal and aromatic plants
iv. Setting up of a radio-tracer laboratory	To study the nutritional requirements of medicinal and aromatic plants for increasing the production of active constituents
v. Photosynthesis and productivity in medicinal and aromatic plants	To study the photosynthesis in medicinal and aromatic plants to increase the production of active constituents
vi. Factors controlling essential biosynthesis in medicinal and aromatic plants	To increase the production of active constituents
vii. Study of plant growth regulators in medicinal and aromatic plants in relation to dormancy of tuber and seeds	To break the dormancy of tuber and seeds for early sprouting
viii. Effects of nutrients on biosynthesis and growth of medicinal and aromatic plants	To increase the production of active principles
ix. Development of strains of medicinal and aromatic plants resistant to fungal and viral diseases	Increased productivity
x. Screening of natural flora for insecticides including sex attractants and juvenile hormones	To study natural flora for development of new sources of insecticides
	NBRI
xi. Development of seeds in certain economically important taxa	Studies on seed development of economic taxa for increased production
	RRL, Bhubaneswar
xii. Experimental plantation of fast growing trees in Orissa	Plantation of fast growing trees for essential oils and biomass production

xiii. Improvement of aromatic and medicinal plants (CSIR-ICAR Project)	To develop superior clones for increased productivity
xiv. Plant resources survey of Koraput district of Orissa	Survey of the area which might result in availability of potential and hitherto unknown plants

RRL, Jammu

xv. Utilisation of essential oil-bearing plants and development of aroma chemicals	To produce aroma chemicals of economic importance from essential oils for internal needs
xvi. Cultivation of drugs used in indigenous systems of medicine	Cultivation of medicinal herbs used in indigenous systems of medicine
xvii. Conifers utilisation	Utilisation of conifers for essential oils and other important economic products

FINANCIAL PROJECTION

R & D

(Rs. in lakhs)

Sub-Area	1985-86	86-87	87-88	88-89	89-90	Total
Medicinal and Aromatic Plants						
a) Ongoing projects	93.04	96.06	90.90	98.95	100.63	479.58
b) New projects	80.94	48.48	51.91	49.58	48.43	279.34
Economic plants						
a) Ongoing projects	29.03	25.99	25.72	27.20	28.75	136.69
b) New projects	3.40	3.55	2.75	3.00	3.25	15.95
Phytosalinity						
a) Ongoing projects	17.93	19.34	21.00	20.56	21.39	100.22
b) New projects	9.51	18.20	12.88	8.60	5.37	54.56
Marine Algae						
a) Ongoing projects	34.87	38.15	22.05	25.69	21.89	142.65
b) New projects	-	-	-	-	-	-
Utilization of usar land at Aligarh and marginal soils						
a) Ongoing projects	11.40	6.20	6.60	6.00	6.45	36.65
b) New projects	-	-	-	-	-	-
.2 INFRASTRUCTURE						
Medicinal and Aromatic Plants						
a) Ongoing projects	42.30	43.82	45.57	47.35	54.22	233.26
b) New projects	28.47	47.14	45.82	40.17	37.48	199.08

Sub-Area	1985-86	86-87	87-88	88-89	89-90	Tota
2. Economic Plants						
a) Ongoing projects	39.68	38.32	36.03	37.05.	36.90	187.
b) New projects	-	-	-	-	-	-
3. Marine Algae						
a) Ongoing projects	-	-	-	-	-	-
b) New projects	24.55	10.46	5.31	7.77	5.22	53.
4. CSIR Complex at Palampur						
a) Ongoing projects	-	-	-	-	-	-
b) New projects	100.00	100.00	100.00	100.00	100.00	500.
5. Tea						
a) Ongoing projects	105.00	110.00	120.00	130.00	140.00	605.
b) New projects	7.50	10.00	10.00	10.00	10.00	47.
Total	627.62	615.71	596.54	611.92	619.98	3071.

+ NBRI has shown a requirement of Rs 440.93 lakhs for infrastructure of the Institute and Rs 123.15 lakhs for Banthra Research Station. The total comes to Rs 564.08 lakhs. 1/3rd of it has been shown here.

++ Based on sanctioned estimates for 1982-83 (Rs 2 crores), half the amount has been shown here. (Tea Research Association).

Industrial Toxicology

AREA: INDUSTRIAL TOXICOLOGY

Participating Laboratories

- Industrial Toxicology Research Centre
  Lucknow — ITRC

- Regional Research Laboratory
  Hyderabad — RRL (H)

- National Environmental Engineering
  Research Institute,
  Nagpur — NEERI

Contents

		Page
1.0	Review of Progress and Achievements	77
2.0	Perspectives	89
3.0	S & T Programme for Seventh Plan	90
4.0	Major Infrastructural Needs	100
5.0	Financial Projections	102

1.0 REVIEW OF PROGRESS AND ACHIEVEMENTS MADE DURING APRIL 1980 TO DECEMBER 1983

Industrial Toxicology is a multidisciplinary area wherein the harmful effects of pollutants in the occupational environment of workers and related effects on ecological balance are assessed and knowhow developed for detection and prevention so that welfare and productivity are protected. Therefore, the outputs from this area are the services rendered towards this goal. Towards the aim of developing expertize in this area, to see that India's industrialization is not accompanied by such pollution problems, CSIR initiated an active programme. For the purpose of review, the hard outputs are considered to be the direct social benefits and soft outputs the toxicological research findings.

1.1 Physical Output Indicators:

1.1.1 Hard outputs

Social welfare:

- Industrial hygiene surveys in various occupations conducted and potential health problems to workers identified e.g. mining, chemical industry.

- The extent of pollution of workroom and community environment by industrial chemicals and their products quantified through monitoring.

- Analysis of various food items, water and soil for toxic substances like pesticides, heavy metals, dyes etc.

- The endemic paralysis in Unnao villages evaluated causative factors identified.

Improvement of quality and productivity

- Evaluation of safety to non-target organisms and workers, of several pesticides and industrial chemicals and pollutants conducted.

- Occupational Health Clinic at Kanpur is engaged in diagnosis and treatment of workers afflicted with several industrial diseases.

- Safety evaluation and quality control of synthetic detergents manufactured in various sectors in India conducted and Indian standards developed.

- Actively engaged in development of Threshold values for hazardous chemicals in the working environment, ambient air quality standards and environmental quality management criteria.

Nationally important infrastructural facilities
ITRC

- Central facility for toxicological evaluation of pesticides and other industrial chemicals including genotoxicity and cytotoxicity.

- Documentation of toxicological information on important toxicants.

- Biodegradation of pollutants.

- Immunotoxicology.

- Ecotoxicological field studies.

RRL (H)

- Bioefficacy, structure activity relationship.
- Target enzyme interaction and selectivity.
- Hematology, urine and blood chemistry.
- Histopathology and chemistry

- Neuro and delayed neurotoxicity.

- Metabolism.

1.1.2 Soft Output

ITRC

A. Achievements

Toxicity of dyes and dye intermediates

- Has relevance to the welfare of workers handling dyes both in production and use, health implications of coloured food-stuffs among rural/urban population.

- Acute and short-term toxicity and metabolism studies on metanil yellow, p-aminodiphenylamine and orange two studied.

- Study of the mechanism of action of benzanthrone with skin and mode of interaction of benzanthrone with biomacromolecules.

- Studies on the extent of illegal incorporation of prohibited dyes in foodstuffs - a ten year survey (rural/urban population)

- Detection of synthetic dyes in house hold species, especially turmeric.

- Development of a sensitive test to monitor urinary amine in workers

- Miscellaneous studies - Analytical report on Jawar samples, identification of toxic constituents of groundnut cake, analysis of mustard oil samples and examination of dropsy cases, detection of carcinogenic aromatic amines in food and textile dyes samples. Sponsored schemes were undertaken and completed.

Metal Toxicity

(Relevance to the welfare of miners, jewellery and petrol pump workers and industrial workers and general population)

- Simultaneous exposure to lead and manganese either in the work environment or through polluted environment may be more deleterious to the biological system even under the permissible levels of the two metals.

- Coexposure to lead and manganese during pre and post natal life revealed that coexposure during gestation period is more injurious to the development of brain than identical exposure during lactation. These findings are of great significance in understanding the harmful effects on growing brain exposed to chemical in utero.

- The animals maintained on vitamin B deficient diet showed an increased vulnerability to the neuro-and systemic toxicity of lead. These investigations revealed that vitamin B complex deficiency may be more hazardous in lead poisoning particularly among children. Severity of lead and cadmium poisoning can be reduced by the simultaneous supplementation of vitamin B complex.

- Diagnostic parameters for early detection of manganese poisoning developed.

- Developed a model of liver regeneration to study the action of toxic metals on the target tissue of growing systems, in order to extrapolate the risk of exposure of metals to human subjects.

- Isolated a few complexes of metal pesticides to test the bioefficacy against various dangerous pests responsible for damaging crop production.

- Surveyed the newly started Sargipali mines in Orissa to measure the initial level of lead in workers and in environment to monitor and evaluate the long-term exposure.

Industrial and Environmental Carcinogenesis

(To evaluate carcinogenic potential of industrial chemicals and environmental pollutants, applicable to industrial workers and general public)

- Two varieties of jute batching oil (JBO) were tested for its carcinogenic effects. Tumors were successfully developed in Swiss albino mice after skin painting with JBO.

- Techniques have been developed to evaluate carcinogenic or cocarcinogenic potential of mineral oils and solvent used in industries.

Pesticides and Agrochemicals Toxicity

(Direct relevance to rural development, agricultural and industrial workers, general population through residues)

- Toxicological evaluation of several pesticides in laboratory animals, including neurotoxicity, fish and birds referred by industries and CSIR laboratories carried out.

- Evaluation of interaction and synergistic effect of agrochemicals with other chemical compounds in laboratory animals, fish and birds studied.

- Reproductive, mutagenic and teratogenic studies of pesticides in laboratory animals conducted.

- Facilities for plant tissue culture have been developed to use culture technology to raise pollution resistant plants.

- Capabilities for phytotoxicity studies in relation to safety evaluation of pesticides have been developed.
- Morphological and behavioural alterations were evaluated in cat fish, insect nymph and tadpoles of frog following short-term exposure to sublethal levels of endosulfan.
- Effect of pesticides on mental function and sex hormones investigated.
- Neuroretinal changes in pesticide workers reported.
- Health surveys in pesticide sprayers continued.
- Pesticide residue levels in humab body tissue, food material, meat and meat product, fruits, vegetables, milk and milk products determined.
- A method standardized for biological monitoring of pesticides, especially in placenta, unbilical cord, maternal blood, mother's milk etc.
- Role of pesticides in abortions and premature labour studied.

Toxicity of Petroleum (Energy resources Compounds)
(Relevance to the welfare of industrial and laboratories workers handling solvents)

- Hepatotoxicity and haematotoxicity effect of hydrocarbon compounds were observed on laboratory animals.
- Animal model for hexacarbon neuropathy established.
- Health status of petrol pump workers assessed.
- Safety evaluation of protein biomass grown on paraffin hydrocarbons carried out.

Toxicity of Plastics
(Relevance to the welfare of the General community)

- Methods for extractability tests and toxicity evaluation of plastics have been standardized.
- Toxicogenic potential of DEHP, a leachable component of the PVC plastics, was higher in younger animals than adults.
- Studies on the monomer acrylamide have shown that this neurotoxic substance produced its neurotoxicity by affecting the neurotransmitter function.

- Studies on the mechanism of toxicity of monomer, styrene-showed that this monomer altered the bio-transformation capability of brain, liver and kidney.

- A method to screen the neurotoxicity of industrial and environmental pollutants has been developed.

Industrial Dusts and Chemicals

(Relevance to the welfare of miners and industrial workers exposed to dust)

- Effect of quartz dust on peritoneal exudate cells in rats studied. Quartz content of coal-mine dust is probably a significant contributing factor in the development of massive fibrosis in coal workers pneumoconiosis.

- Cytotoxic and haemolytic action of coal quartz mixtures investigated.

- In vitro studies revealed that toxicity of the dust obtained from slate pencil manufacturing industries was mainly by virtue of its high silica content.

- Agate dust exposure resulted in the development of lesions in lungs.

Ecotoxicology of Environmental Xenobiotics

(To protect ecosystems from pollution effects)

- The existence of a protein capable of binding silicon was chracterized and its role in dust toxicity established.

- Experimental microcosms were designed to study ecological effects of pollutants.

- Studies with aquatic flora like algae and duck weeds showed potential ecological effects of detergents.

Toxicological Evaluation of Xenobiotics

- Isolation and characterization of plasma membrane and basement membrane from skeletal muscle of frog.
- Use of intestinal loops in anaesthetized rats for transport studied.
- Techniques for studying bacterial adherence to mammalian cells.
- Isolation of intestinal epithelial cells for studies on intact viable cells.

Epidemiological Studies

(Health hazards among workers in small scale and cottage industries and lung disease in mining and industrial complexes).

- A health survey in flour mill workers undertaken.
- All values of the lung function test were significantly lowered in flour workers.
- A health survey in agate industry completed.
- An epidemiological study was undertaken in a cotton spinning mill to identify byssinosis and other non-occupational lung diseases in 549 workers engaged in various section of the mill located in Lucknow.

Environmental Monitoring(In relation to health hazards)

- Preliminary assessment of environmental conditions, in slate pencil industries in Mandsaur district of M.P. carried out.
- Industrial hygiene surveys in saw mills and welding shops in Lucknow conducted.
- Industrial hygiene studies in printing industry.
- Measurement of occupational, community and traffic noise levels.
- Ambient air survey in and around Panki Thermal Power Station (Kanpur, Loco Shunting Yard, Lucknow and Aishbagh-

Mines in Cuddapah (A.P.) and many other sites.

- Monitoring of lead in jewellery shops and heavy metals in silver jewellery industry at Hupari, Kolapur (Maharashtra).

- A collaborative study between ITRC and CBRI, Roorkee on the project "Toxicity of Combustion Products from building materials involved in fire".

Scientific papers	102
Technical reports	25
Books	7(Toxicology Profile)
Journal	1
Air quality monitoring	7
Epidemiological survey	8
Water quality survey	5
Meat analysis	1
Food analysis	1
Detergent safety evaluation	2

B. Sponsored Projects

- Five
- Rs. 30.00 lakhs
- All ongoing
- Indo-US, EPA

- Biochemical effects of particulate air pollutants on lungs Rs. 10.4 lakhs
- Microbial degradation of plastics and polymers Department of Environment Rs. 8.20 lakhs
- Biochemical Ec toxicology of Air Pollutants Department of Environment Rs. 4.88 lakhs
- Integrated Environmental Programme on Heavy Metals Rs. 11.00 lakhs (Department of Environment).

C. Services Provided Indicators

- ITRC Scientists actively participated in ISI standards committees, air quality, permissible levels of toxicants, hazardous substances, tergents etc.
- Toxicology evaluation of a large number of samples from various agencies.
- Evaluation of toxicity and development of safety standards for detergents, food constituents, pesticides.
- Metals, organic chemicals etc.
- Ecotoxicological studies at Ghana sanctury.
- Toxicology data profiles for several chemicals compiled.
- Slate and air documents regarding pesticide residue analysis metal toxicity, environmental toxicology in India, occupational and environmental health problems in India.
- Toxicological knowhow and tolerance impact on specific queries.

D. Financial Flows/Earnings Indicators

- Rs. 30.00 lakhs

E. Education and Training Indicators

- 14
- One week course on occupational hygiene to factory medical personnel, November 1982.
- 45 All Indian
- No fees.

RRL(H)

A. Physical Output Indicators

i) Hard output - Not applicable
ii) Soft Output - (Publications/Patents).

- Toxicology unit at RRL is engaged in study of toxicity on non-target species of pesticides formulations made through R&D programmes in the country and studies on bioefficacy. These studies have a direct bearing on pesticide policy of the country.

- Detailed toxicological evaluation of various pesticides on species like fishes, birds, honey bees and rodents. Mutagenicity, teratogenicity and dermal toxicity and other aspects of pesticides toxicity have been conducted in detail.

- Technical expertise was provided to various organisations working in production and regulation of pesticides. Considerable scope for elaboration of these studies including quantitative structure activity relationship. Identification of pesticide metabolites in different species, ecotoxicology and immunotoxicology of pesticides.

Publications	Papers	11
Papers at International Conferences		1
Patents filed and sealed		Nil
Surveys		Nil

B. Sponsored Projects

Taken up	Nil
Value	Nil
Completed (Those taken up prior to April 1980) Toxicity studies on MCP. formulation	Rs.26.700 recd. during the period.

C. Services Provided Indicators

a) Nil

b) Consultancy services - Analysis, interpretation and validation of test results.

i)	Advisory consultancy relating to Toxicological Evaluation of Dodine	IDL Chemicals Hyderabad	Rs. 15,000/-
ii)	Advisory consultancy on evaluation and interpretation of data on Isoproturon 50%	Lupin Laboratories	Rs. 5,000/-
iii)	Synergism/potentiation studies on cypherkill 25 EC and permasect 25 EC	Hexamer	Rs. 13,700/-
iv)	Advisory consultancy for toxicological evaluation of cyphermethrin and permasect (in progress)	Dexamer	Rs. 67,800/-
v)	Advisory consultancy studies on Cyphermethrin	NOCIL Bombay	Rs. 16,000/-
vi)	Advisory consultancy on toxicity of Fenvalerate	Maltichem	Rs. 15,000/-

D. Financial Flows/Earning Indicators

i)	Cash flow from sponsored projects	Rs. 26,700/-
ii)	Cash flow from consultancy, premia royalty	Rs.1,32,500/-
iii)	External funding	-
iv)	Value of production	N.A.

E. Education and Training Indicators

i) Ph.D's outputs from Universities with the support of CSIR 4

ii)	Training course organised	Duration	No.	Fees recd.
	School on Toxicology of Pesticides	2 weeks	28	Rs.56,000/-

NEERI

The interest of NEERI in the field of Industrial Toxicology is mainly from the angle of toxic effects of various environmental pollutants on ecological species. This area (environmental toxicology) is better to be placed in

the area, environmental technology. However, NEERI could greatly help the other laboratories in the area of environmental toxicology in the identification of toxicological problems of national relevance to be taken up for R&D activities. In the biological monitoring of toxicants also the achievements of NEERI will be useful.

PERSPECTIVES

a) National Needs

Developmental activities for prosperity and welfare through the ideal strategy, where massive industrialization and agriculture proceed without any adverse effect on the health of workers and public exposed to pollutants in occupational and ambient environment and without any effect in natural resources and ecosystem, are the needs of our country. For this, R&D activities for the identification and fore-warning of such problems, assessment and abatement of existing problems and anticipatory and corrective action are the thrust areas in industrial toxicology. In view of the magnitude of applicability, pesticides, and other agrochemicals account for a major sub group. A third area is environmental hazards of pollution,their detection and prevention through environmental and ecological toxicity studies. ITRC, NEERI and RRL could objectively contribute to this. The anticipated outputs in this area are the social benefits of this service facility to protect the health of human beings, live stock crops and ecosystems.

b) International trends

The R&D activities in this area in India are at par with the international trends as evident from the recognition on the international field. ITRC is considered one of the foremost laboratories in this field and has

interaction with various groups in different countries and organisations, like ILO, WHO. ITRC is the regional reference laboratory for these organisations and is actively involved in programme like IPCS, IRPTC. In addition to the international trends. ITRC is engaged in R&D studies under Indian conditions in view of conditions of general health and sanitation, geoclimate, social factors etc. India has to develop its own standards and knowhow. Furthermore, the experience and expertize of India in Occupational and Environmental Toxicology will be highly beneficial to the third world countries also in solving their identical problems.

3.0 S & T PROGRAMME FOR SEVENTH PLAN

R&D outputs at ITRC in the following sub areas have gone a long way in the identification of health problems of occupational workers exposed to toxic chemicals, in the evaluation of safety and in promoting health and welfare. Apart from this service the capabilities developed and accomplishments in toxicological research as evident from Proforma II, also recommend the need for continuing the R&D work in the specific lines as mentioned in Proforma III A.

Dyetoxicity, Metal Toxicity, Industrial and Environmen Carcinogenesis, Safety Evaluation of pesticides and Industrial Chemicals, Pesticides and Agrochemicals, Polyme and Plastics, Industrial Dusts and Chemicals, Ecotoxicolog Biomembranes, Epidemiology and Environmental Monitoring.

Similarly, the toxicology unit at RRL, Hyderabad, has made significant contributions regarding the non-target effects and the safe use of pesticides so that there is considerable scope for further exapnasionsof capabilities.

The services rendered by ITRC research and development has the corresponding industries, Government Departments workers and consumers as the linkages/users with health and welfare as the main social gain. ITRC proposes to expand its activities at the Gheru Campus incorporating the following new sub areas:

Phytotoxicology, Inhalation Toxicology, Cosmetic Toxicology, Phototoxicology, Neurotoxicology and Environmental Carcinogenesis.

In view of the relevance of national R&D needs and the need for assessment and abatement of public health and environmental problems due to pollution, these areas are considered the priorities. Similarly, RRL, Hyderabad, proposes to conduct in depth studies on immuno and eco-toxicology, radiation biology, structure-activity relation and pesticide toxicity which are vital for development. In view of the social benefits of the expected outputs these areas are of priority. It is envisaged that from the experience of NEERI in environmental health, this organisation could help in identification of problems so that ITRC and RRL can take up specific studies if needed.

a) Continuing Projects

Dye Toxicity

Objectives: Mutagenic/carcinogenic potential of metanil yellow, orange II and p-aminodiphenylamine, common dyes in India; Development of skin model to assess exposure hazards due to dyes and photosensitization potential; Surveys to evaluate presence of synthetic dyes into food stuffs of city and rural markets and their toxicity.

Users/Linkages: Dye and Food Industry, Public Analyst Department, Government Agencies, Consumers.

Expected outputs: Studies on food additives, contaminants and adulterants may help to evaluate their impact on social welfare and health and occupational and environmental effects.

Metal Toxicity

Objectives: To investigate the neurobehavioural toxicity and teratology of metals, under chronic low exposure and altered metabolic conditions and test for sex variation in toxic response; To assess the magnitude of heavy metal pollution of environment in urban and rural and idustrial and agricultural sectors; To prepare synthesize new chelating agents and to encapulate chelating agents (liposomes) to screen effectively in heavy metal mobilization in tissues; To conduct clinical investigations on metal toxicity in vulnerable workers for diagnostic/preventive measures To develop metal complexation as a potential means of controlled release of agro-chemicals.

Users/Linkages: Mining and metal industries, Directorate of Mine Safety, Labour Institute, Department of Environment, State and Central Pollution Board.

Expected Outputs: Standard protocols for diagnosis of endemic neutrotoxic outbreak such as due to combination of different metals and other potential due to metals, will help in prevention.

Industrial and Environmental Carcinogenesis

Objectives: To develop capabilities for screening mutagenicity and carcinogenicity of industrial pollutants by microbial cell culture, chromosomal aberration and animal bioassay.

Users/Linkages: Health Ministry and Industrial Health Agencies.

Expected outputs: The extent of the role of pollutants in the incidence of cancer in India can be assessed so that prevention measures can be adopted.

Pesticides and Agrochemicals

Objectives: To evaluate toxicity, including genotoxicity of different pesticide formulations manufactured by national laboratories, public sector undertakings and private industries; To carry out surveillance and monitoring studies to evaluate the residue buildup of pesticides in humans and environment and their prevention; To determine the effect of common drugs or pharmacological agents on the neurochemical changes due to the toxicity of pesticides; Pesticide-endocrine interaction and sex variation in toxic response; Plant and soil metabolism studies with pesticides; To observe the behavioural indexes and the resulting changes in physiological and biochemical response in non-targets like fresh water fauna; Detailed electrophysiological investigations to detect muscle and nerve dyefunctions due to pesticide exposure in animal models and from biopsy of pesticide exposed subjects; To evaluate potential role of pesticide residues in reproductive system.

Users/Linkages: Pesticde Industry, Government Agencies, Food Industry, Vector Control, Agricultural Workers.

Expected outputs: Above studies will help in developing criteria for the safe use of pesticides in the country.

Toxicity of Petrochemicals

Objectives: Comparative metabolism and hematotoxic effects of other aromatic hydrocarbons like xylene, toluene and ethyl benzene and carcinogenic potential will be studied; Central nervous system effects like dopamine receptor binding and alteration in MAO and thymic atrophy and lymphocytotoxicity metabolites of hexane.

Users/Linkages: Workers handling hydrocarbon, petroleum and petrochemical industry.

Expected outputs: Immunotoxic effects of metabolites of hexane and kerosene will be of immense value to the rural masses as they are virtually exposed to these compounds.

Toxicity of Plastics

Objectives: Safety evaluation of plastics, raw materials, ingradients; Facilities of capabilities to be developed for gastational and neonatal toxicity studies of plastics additives; Studies on pharmacokinetics of the leachable components of plastics.

Users/Linkages: Plastic and Chemical Industry, Consumers.

Expected outputs: Knowhow for safe use of plastic.

Industrial dusts and chemicals

Objectives: To understand the mechanism of cellular response, clearance cytotoxicity and lung pathology following exposure to industrial dusts and chemicals, either singly or in combination; To use cell culture for screening of various particulate and fibrous dusts obtained from different mines and industry for predictive pulmonary toxicological evaluation; Monitoring of food animals from selected industrial belts of chemical induced alterations in lymphoid organs; Myelotoxicity, biochemical studies of immunocompetent cells and lymphoid organs and their ultrastructural studies together with local immunity of lungs and GI tract will be developed.

Ecotoxicology of Environmental Xenobiotics

Objectives: Biological monitoring for toxic residues, their effects and biodegradation and environmental quality surveys. Evaluation of safety of humans and assessment of ecological impact of synthetic detergents; Experimental studies on ecotoxicology will be continued taking heavy metals and organic compounds of national relevance;

Comparative biochemical features of different species, especially, the dealing of foreign substances, will be continued taking heavy metals and organic compounds of national relevance; Comparative biochemical features of different species, especially, the dealing of foreign substances, will be studied to understand molecular basis of selective toxicity; Other thrust areas on the occupational and environmental health problems of Indian women and the water quality at national parks to be taken up.

Users/Linkages: Department of Environment (State and Central) National Parks, Pollution Control Boards.

Expected outputs: Capabilities for environmental impact analysis of pollutants will be applied for identifying potential ecological disbalance.

Toxicological Evaluation of Xenobiotics

Objectives: Model test systems like liposome, erythrocytes and muscle membranes, will be used to study biomembrane as target on toxicants by biochemical and ultrastructural parameters; *In vivo* and *in vitro* studies of the effects of xenobiotics on the interaction between microorganisms and intestinal cells and on bacterial surfaces.

Expected outputs: It is an on deptn basic study on molecular toxicology.

Epidemiological Studies

Objectives: A certain health hazards in different industries. Followup and longitudinal studies to review the effects of industrial pollutants in various industries; To establish threshold limit values (TLVs) for industrial toxins; To act as a referal centre for various occupational problems encountered in various industries in liaison with the Labour Department, U.P. Government; To suggest preventive measures for maintaining the health of working population.

Users/Linkages: Respective industries, Labour force, Occupational Health Agencies, Medical Practitioners.

Expected Output: Any health problems of several industries will be assessed so that workers health can be safeguarded.

Environmental Monitoring

Objectives: Indoor air pollution due to combustion of fuel during cooking in rural and urban areas; Studies on pollutants in potable water in rural and urban areas; Assessment of toxic chemicals in ambient environment of agriculture fields.

Users/Linkages: Pollution Control Board, Department of Environment.

Expected outputs: Assessment of potential health risks of workers.

Occupational Health Clinic, Kanpur

Objectives: To develop institutionalized capabilities in diagnosis and clinical management of diseases of occupational aetiology; Consultancy on diagnosis, prevention and treatment of referred cases of occupational diseases.

Users/Linkages: ESIS, Factory Medical Personnel, Labour Welfare.

Expected outputs: Diagnosis and treatment of cases of industrial diseases in Kanpur.

b) New Proposals

The following new areas/thrust areas have been initiated/ proposed to be initiated at the Gheru Complex of ITRC.

Establishment of Phytotoxicology Laboratory

Objectives: To develop expertise to plants for monitoring toxic effects and elucidating mechanism of action of chemicals and also the development of pollution resistant plants employing tissue culture technology; Evaluation of phytotoxicity and biotransformation of environmental xenobiotics.

Users/Linkages: Agriculture Department, Department of Environment. Farming.

Expected outputs: Study of the damaging effects of air pollutants on common Indian economic plants; Development of simple biological parameters for monitoring of air pollutants; Identification of plant species resistant to air pollutants which could be planted in urban and industrial areas for mitigrating ill effects of air pollution.

Phototoxicology Laboratory

Objectives: To design methods for safety evaluation of the phototoxicity of common pollutants like pesticides and dyes, drugs, and food additives, detergents and health care products and chemicals released from industrial effluents, coaltar and exhaust systems. In tropical countries like India abundant sunlight super imposed on environmental pollutants, may aggravate toxicity; Induction of skin photosensitization, redness (erythroma) edema, and tumor responses upon topical and oral application with or without sunlight and study the role of active free radicals; Ability of toxicants to bind photochemically with cutaneous cell components like DNA, RNA, enzymes, collagen and lipids in in vitro and in vivo. Determination of photodynamic oxidation potential with quanine and thymine bases of DNA, RNA, metal protein and enzymes and lipids.

Users/Linkages: Dermatologists, Cosmetics users, Allergy Clinics.

Expected outputs: The proposed project will help people understand the short and long-term phototoxic and genetic effects of combined exposures of light and environmental pollutants. Apart from skin phototoxicity, the findings may help agricultural scientists better understand the genetic abnormalities in crops and vegetables due to sunlight and chemical agents induced photodynamic oxidation processes. Methods for protection to skin against damage may ensure.

Inhalation Toxicology Laboratory

Objectives: In view of the fact that most of the agro-chemicals and air pollutants evaluation of their effect on inhalation is essential in preventing toxicity. Inhalation toxicity studies for exploring acute and long-term chronic effects of air pollutants will be undertaken; To help in creation of basic facilities for conducting inhalation toxicology studies; To study the deleterious effects of potential airborne toxicant and noxious agents in lungs and other biological tissues of laboratory animals.

Users/Linkages: Occupational Health personnel, Labour Institute, Factory Physicians.

Expected outputs: The capabilities and R&D outputs will help standards for

- Maximum exposure limits,
- Maximum allowable conc. (MAC values), threshold limits values (TLVs).

Cosmetics Toxicology Laboratory

Objectives: Among all the industrial chemicals, detergents and cosmetics constitute a group which reaches every home in our country, making a large proportion of the Indian population prone to possible hazards of daily exposure. Due to personal inheritance including malnutrition, lack of awareness and economic constraints and water quality, climate the chances of hazards due to faulty formulations are likely to be quite high in Indian population as compared to that of developed countries. Therefore, it is essential to assess the impact of widespread use of synthetic detergents and cosmetics at the consumer level, and to develop capabilities for dermal toxicity evaluation.

Users/Linkages: ISI, Department of Industries, Detergent, Soap and Cosmetic Industry, Consumers.

Expected outputs: The national standards for safety, the assessment of effects on consumers and on occupational workers are likely to emerge.

Environmental carcinogenesis Laboratory

Objectives: In man 85-90% cancer occurrence has been attributed to the exposure of one or multiple varieties of chemicals at certain time during their life span and the early detection of this dreadful and silent desire is often not possible. The mutagenic ability of most of the carcinogens may serve in the development of many *in vitro* tests system, such as microbial, cell culture, chromosomal aberrations and detection of tumor following long-term administration of test chemicals.

Users/Linkages: Health monitoring, industrial workers, occupational health, Department of Environment.

Expected outputs: The R&D outputs will help in forwarning cancer risk of new industrial chemicals and pollutants.

4.0 MAJOR INFRASTRUCTURE NEEDS

New sub groups for new emerging area:

1. Phytotoxicology
2. Inhalation Toxicology
3. Cosmetics Toxicology
4. Environmental Carcinogenesis
5. Phototoxicology
6. Neurotoxicology

Infrastuructural to be created:

1. Gheru Campus
   - Building for Inhalation Toxicology Laboratory
   - Building for Cosmetics, Environmental Microbiology
   - Neuroteoxicology and Environmental Carninogenesis Laboratories
   - Residential Quarters
   - Animal Breeding Facility
   - A small Primate House
   - Construction of a Glass House
   - Construction of a Residential Hostel for Trainees
   - Sophisticated Instruments.

2. Main Campus
   - Additional Block to house Infrastructure Facilities

3. Occupational Health Clinic, Kanpur
   - Land and building for Occupational Health Clinic at Kanpur

New sub-groups for new emerging areas

ITRC, Lucknow

Phytotoxicology, Inhalation Toxicology, Cosmetic Toxicology

Phytotoxicology, Neurotoxicology and Environmental Carcinogenesis.

RRL, Hyderabad

Radiation biology, Immuno and Eco-toxicology of pesticides.

5.0 FINANCIAL PROJECTION FOR THE AREA: INDUSTRIAL TOXICOLOGY (Rs. in Lakhs)

Sub Area	Laboratory	1985-86	1986-87	1987-88	1988-89	1989-90	Total
I (a) Continuing							
Dye Toxicity	ITRC	1.8	1.9	2.1	2.3	2.5	10.6
Metal Toxicity	ITRC	5.7	6.1	6.7	7.3	8.0	33.0
Industrial Carcinogenesis	ITRC	1.5	1.7	1.8	2.0	2.5	9.5
Safety Evaluation of Pesticides, Industrial Chemicals	ITRC	1.8	1.9	2.1	2.3	2.5	10.6
Pesticides and Agrochemicals Toxicology	ITRC	7.2	7.9	8.7	9.6	10.5	43.9
	RRL	8.0	8.0	8.0	8.0	8.0	40.0
Polymers & Plastics	ITRC	3.7	4.0	4.4	4.8	5.3	22.2
Industrial Dusts and Chemicals	ITRC	3.0	3.3	3.6	3.9	4.3	18.1
Ecotoxicology	ITRC	1.5	1.7	1.8	2.0	2.2	9.2
Biomembranes	ITRC	0.9	1.0	1.1	1.2	1.4	5.6
Epidemiology and Environmental Monitoring	ITRC	3.8	4.1	4.5	4.9	5.4	22.7
(b) New Areas							
Phytotoxicology	ITRC	3.8	5.8	7.3	8.7	9.8	35.4
Inhalation Toxicology	ITRC	4.2	6.5	8.2	9.5	10.5	38.9
Cosmetics Toxicology	ITRC	3.5	5.5	7.2	8.5	10.0	34.7
Phototoxicology	ITRC	3.2	6.2	7.2	8.5	10.0	35.1
Neurotoxicology	ITRC	4.0	6.0	7.7	9.0	10.5	37.2
Environmental Carcinogenesis	ITRC	3.0	5.0	6.5	8.0	9.0	31.8
Radiation Biology	RRL						12.0

Sub Area	Laboratory	1985-86	1986-87	1987-88	1988-89	1989-90	Total
Immuno and Eco Toxicology of Pesticides	RRL Hyderabad	4.0	4.4	4.8	5.2	5.6	24.0
Pesticide Toxicology	-do-	4.0	4.4	4.8	5.2	5.6	24.0
II. New Sub-Group							
Environmental Toxicology	ITRC	3.0	3.2	3.6	4.0	4.2	18.0
Toxicology	RRL,Hyd.	3.0	3.2	3.6	4.0	4.2	18.0
	NEERI, Nagpur	4.0	4.4	4.8	5.2	5.6	24.0
III. Infrastructure for the areas	ITRC	136.5	95.0	97.0	40.0	40.0	408.5
	NEERI, Nagpur	10.0	10.0	7.5	7.5	5.0	40.0
	RRL,Hyd.	20.0	20.0	20.0	20.0	20.0	100.0
IV. Total for Chemicals etc. (P4, P5, P7)							
Continuing & Miscellaneous	ITRC						
	Cont.	106.0	115.0	124.0	132.0	142.0	619.0
	New	25.0	31.0	27.0	24.0	25.0	133.0
	RRL						
	Cont.	2.0	2.5	3.0	3.5	4.0	15.0
	New	3.0	3.5	3.5	4.0	4.0	18.0
	NEERI						
	New	3.0	3.5	3.5	4.0	4.0	18.0
Total (I+II+III+IV)	ITRC						1577.0
	RRL, Hyderabad						251.0
	NEERI, Nagpur						82.0
							1810.0

Applied Biology (Immunology, Diagnostics)

AREA: APPLIED BIOLOGY

Participating Laboratories

- Central Drug Research Institute, Lucknow — CDRI
- Indian Institute of Chemical Biology, Calcutta — IICB
- National Environmental Engineering Research Institute, Nagpur — NEERI
- Regional Research Laboratory, Hyderabad — RRL(H)
- Regional Research Laboratory, Jorhat — RRL(Jorhat)
- Regional Research Laboratory, Jammu — RRL (Jammu)

CONTENTS

		PAGE
1.0	Review of Progress end Achievements	106
2.0	Perspective	113
3.0	Programme for Seventh Plan	117
4.0	S & T Sub-groups for Emerging Areas	124
5.0	Infrastructural facilities to be created	125
6.0	Financial Projections	126

1.0 Review of Progress and Achievements made during April 1980 to December 1983

Applied Biology is a multidisciplinary area wherein the medical and biological problems in the diagnosis of the diseases based on differences between the host and parasite enzymes, biochemical pathways and regulatory mechanisms are assessed. Drug design related to biochmistry of the disease process and of the parasite at the molecular level are assessed and knowhows are developed to diagnose diseases. New compounds from biological resources for human population stabilisation and pest control so that health, welfare and productivity are protected. Therefore, the outputs from this area are the technologies and applied biological research rendered towards this goal. Towards the aim of developing expertise in this area, to see that India's health and prosperity CSIR initiated an active programme. For the purpose of review, the hard outputs are considered to be direct technological benefits and soft outputs the applied biological research findings.

1.1 Physical output indicators

1.1.1 Hard output

A) IICB

a) No. of technologies in production: preparation of gelatin optical filters.

b) No. of technologies offered/released: experimental production of lectins.

c) Products and processes that have gone into production: Gelatin optical filters.

d) Technologies for research exploration and exploitation: i) Lectins ii) Extraction of diosgenin fram Kallstroemia pubescens

e) Infrastructural facilities created: Electron microscope; NMR, mass and ORD-CD spectrometers; Liquid scintillation counter; Amino acid analyser; HPLC, spectro-photo-flourimeter.

B) RRL (Hyderabad)

Pesticidal evaluation of target organisms like insect, fungi and weed from synthetic/natural resources. Biological control of water hyacinth.

1.1.2 Soft outputs:
Achievements

A. IICB

i) A number of cases of micoplysaccharidosis and phenylketonuria were identified on the basis of enzyme deficiency studies. These investigations would be useful for the genetic counselling of parents at risk.

ii) MAO types can be selectively inhibited in the brains of laboratory animals hence can be used as models for neuropharmacological and psychopharmacological studies.

iii) Major effects of thyroid hormones during brain development is to regulate the biogenesis of tubulin required for the formation of cellular processes.

iv) Protoplasmic astrocytes representing the bulk of brain cells, have been isolated, purified and their membrane markers characterized.

v) Important basic mechanisms of neurotransmitter release process have been unearthed by discovering the existence and functional role or presynaptic muscarinic and PG receptors on cholinergic nerve terminals.

iv) Role of motoneurons in tremorogenesis was elucidated through biochemical confirmation of Renshaw Cell inhibition.

vii) Spinal and peripheral mechanisms responsible for the genesis of parkinsons disease have been elucidated. A balance between motor output and recurrent inhibition in the spinal cord and adfective bias of muscle spindle afferent discharges have been implicated in the genesis of tremor, an important feature of Parkinson's disease.

viii) New anti-parkinson drugs, namely cetane dichol and propranolol with sites of action at peripheral sites rather than CNS, have been identified.

ix) Proteins of the scorpian venom were fractioned. The pharmacological profile of some of the proteins exhibited novel biological properties affecting membrane function which can be used as neurobiological research tools.

x) Aristolic acid from Aristolochia indica has shown potent antifertility effect in lower animals. The compound shows anti- implantation and interceptive effect depending on the time of its administration.

xi) The role of dead embryos in corpus luteal function in early pregnant rats has been determined.

xii) Neutral epididymal α-mannosidases and cyclic AMP dependent protein Kinases and testicular phospho-protein phosphates have been partially purified and characterised. Ecto-ATPase and protein Kinase activities have been demonstrated in rat epididymal spermatozoa.

xiii) A new type of gel scanner has been developed to record protein separation in gel electrophoresis directly on a recorder.

xiv) A continuous flow type colorimeter has been developed in which the absorbance of a coloured liquid flowing through the tube can be measured and plotted on a recorder.

xv) Publications etc.

Scientific papers - 285
Technical reports - 4
Papers presented at international conferences - 50
Patents filed - 12 filed
Sponsored projects - 3
Cash flow from sponsored projects - Rs.2.25 lakhs.
Value of production - Rs.1.75 lakhs.
Ph.D. outputs with CSIR support - 28
D.Sc. outputs with CSIR support - 2
Training course - 1 (No. of trainees 35)
Summer school conducted - 1 (No. of trainees-30)
Workshop conducted - 1
International symposia conducted - 4
National symposia conducted - 4

B. CDRI

i) Monkeys infected with P. Knowlesi showed changes in structure and phospholipids of membranes of both parasitised and non-parasitised red cells, including changes in some membrane enzymes. G-6-PD in ring, trophozoite and schizont stages of P. Knowlesi infected erythrocytes increased with rise in parasitaemia and therefore could be used in prognosis of malaria. P. Knowlesi proteases seem to be involved in parasite invasion of RBC's and protease inhibitors seem to prevent invasion.

ii) Scihzont - infected red cells have been cultured in vitro and purified merozoites obtained were formed to be metabolically active and non-infective.

iii) In rats infected with P. berghei, acid hydrolases in spleen decreased initially and then increased progressively with development of immunity, thereby showing a causal relationship with host resistance.

iv) In a study of the metabolism of filarial worms it has been found that microfilarie of S. cervi and L. carinii were metabolically more active than adult worms. Further, freshly expelled mf nerve metabolically more active than blood mf.

v) In a study of the action of antifilarial drugs it has been observed that suramin blocked some of the energy metabolism enzymes of the filarial parasites S. cerir and B. malayi while DEC and centperazine had little effect.

vi) In a study of the membrane structure of filaril worms the mf of B. malayi were found to undergo 90-100% exsheathment with proteolytic enzymes along with ca^{++}. The sheath was mainly composed of glycoproteins, phospholipids and mucopolysaccarides. Cuticle of adult filarial parasites has been shown to possess mechanisms for the transport of methyl glucose, C-AMP and isoproterenol

vii) Virulence of E. histolytica has been shown to be closely related to its phospholipase A and lysosomal activities, haemolytic property, cholesterol content and Con-A agglutinable property; membrane bound haemolytic factor is distinct from amoebic cytotoxin.

viii) Amoebic infection of liver in hamsters causes marked reduction in drug metabolizing enzymes and electrotransporting components and marked increase in acid hydrolases and alkaline phosphatase; these changes cannot be reversed by amoebicides.

ix) Two phosphoglucoisomerases were found to be significantly higher in avirulent than in virulent strains of E. histolytica.

x) Wild strains of V. cholerae manipulated to contain both P^+ and V^+ plasmide showed full or partial loss of pathogenicity due to inhibition of biosynthesis of toxin.

xi) The factors responsible for adherence and colonization of cholera vibrio to intestinal mucosa have been characterized; glucosa, sucrose and milose - sensitive haemagglutinins play a role in adherence; mucosal cells appear to have receptors for sugars.

xii) Sperms in rats and monkeys showed 65% reduction in their zinc content during maturation. Estrogen treatment in rat interferes with reduction in zinc content during epididymal transport of spermatozoa, thereby suggesting that its antifertility effect is due to inhibition of sperm maturation. Zinc level in epididymal spermatozoa could therefore be used as a marker of sperm maturation. Zinc content of epididymis in immature monkey is regulated by estrogen and that of prostrate by androgen.

xiii) Occurence of adrenoceptors in the cortical neurones has been confirmed. The mechanisms of action of clonidine has been investigated by studying the effect of acetylcholine, noradrenaline and clonidine on the vaso active neurones of ventral surface of media.

xiv) Studies on excitation - contraction coupling in heart showed that the vagal effect is modified by Ca at two sites. Presynaptic Ca facilitates release of ACh and postsynaptic muscarinic receptor - activation inhibits Ca channel activity in atria.

xv) A correlation was observed between diabetes and glycosylation of haemoglobin and plasma proteins in humans, suggesting that glycosylation is an index of hyperglycaemia. A correlation was observed between lysosomal enzymes and tritiated leucine incorporation into pro-insulin. L- Rhomnose stimulated synthesis and release of pro-insulin.

xvi) Publications etc.
Scientific papers - 150
Papers presented at international conferences-6

C. RRL (Hyderabad)

i) Entomology Division at RRLH is engaged in study of developing specific and selective compounds and their formulations made through R&D programmes based on insecticidal evaluation and evaluation of bioactive components from plant/synthetic resources for behavioural manipulation for pest control. Detailed pesticidal evaluation has been done on various compounds and formulations for sex pheromones, growth and reproductive inhibitors, feeding deterrants and chitin synthesis inhibitors.

ii) Biological control laboratory unit developed protocols for biological control of aquatic weed like water hyacinth based on predators, exotic and indigenous insect pests and pathogenic fungi have been carried out in detail.

iii) Publications etc.

Published papers - 15
Review paper - 1
Ph.D. degree awarded on CSIR Support - 1
International conferences organised - 1

D. RRL (Jorhat)

i) The hydrocarbon transport into the microorganism is mediated by a factor produced by the microorganism which help in the solubilization of the hydrocarbon. Experimental evidence has been obtained to demonstrate the production of the solubilizer and the same has been isolated in a crude form.

ii) Published papers - 7

2.0 Perspective

2.1 National needs

Drug research is a highly sophisticated and multi-disciplinary system. The spectacular advances made in recent years in Cellular and Molecular Biology have now made it possible to study the biological uniqueness of each living form/species. One can now hope to find out the differences between the host and parasite enxymes, bio-chemical pathways and regulatory mechanisms. Drug design, which was so far empirical and based primarily upon lead structures, can now be more rational,

based upon an understanding of the bio-chemical pathway or molecular structure of the enzyme or the receptor to be affected or blocked. The slowing of the discovery of new drugs is partly attributed to an exhaustion of the exploitable simple leads that were available. If drugs have to be discovered for diseases where effective drugs are not available, it would be necessary to understand those diseases/parasites at the Cellular and Molecular level. This underscores the need to step up greatly basic research directed to an understanding of the bio-chemistry of the disease process and of the parasite at the molecular level.

The current medical and biological problems of the country need special emphasis on development of methods for the diagnosis of pathological condition; hence development of the techniques for the easy to handle and cheap diagnostic kits. For human population stabilisation new antifertility compounds and clinical acceptability have to be affirmed. Methods based on enzyme deficiency for diagnosing in-born errors of metabolism leading to sub-normalities and bio-genic agents from biological resources pharmacological activities have to be explored for commercial exploitation.

Government bodies have requested for the development of indigenous, safe pesticides, from plant and synthetic resources to control susceptible/resistant populations of insect pests in the country. CSIR Labs. have developed expertise in the development of a series of new compounds and bioactive components from plants. There is a need for highly sensitive and rapid screening of a series of fractions in trace amounts to work hand-in-hand with the chemists, so that feed-back data

obtained from the testing can be biologically characterised and utilised to modify chemical structures to the desired types, if necessary. Moreover, basic mechanisms of some biochemical and microbial processes are likely to make considerable impact on the existing technology of pesticide and oil pollution control.

Water Hyacinth is an environmental problem in 40 tropical Countries including India. There is a national need to control Water Hyacinth as it is a menace to rivers, dams, waterways, irrigational canal and help spread malaria and kill other aquatic flora and fauna by shutting out oxygen.

CSIR has developed expertise in utilising water hyacinth for making papers, boards, fodder, proteins, pollutional control, waste water treatment bio-gas and bio-fertiliser. But, in areas where it is a serious weed effecting navigation, fishing, water loss from reservoirs CSIR is in the process of developing protocols to control water hyacinth.

It is in these directions facilities for development of new drugs/bio-active agents/pesticides and their bio-chemical mechanism of actions from synthetic and natural resources be strengthened. IICB, CDRI, NEERI, RRL (Jammu), RRL (Jorhat) and RRL(H) could objectively contribute to this. The anticipated outputs in these areas are the development of new approaches in disease, population and pest control agents.

2.2 International Trends

Efforts in search of new and novel molecules are continuing through out the world. The R & D activities in this area in India are at par with

the international trends. In addition to the international trends, IICB and CDRI are engaged in R&D studies under Indian conditions in view of diseases prevalent, host/parasite relationship, bio-chemical andregulatory mechanisms, etc., India has to develop its own standards and know-hows. Furthermore, theexperience and expertise of India in developing biologically active agents drugs and their bio-chemical mechanisms of action will be highly beneficial to the developing countries in solving their identical problems.

Developing countries all over the world have been the scene or rapid changes promoted as a part of a National Development. Adequate food nutrition for the increasing populations are to be strengthened with naturallyoccuring and newly synthesised pesticides and their potential to control insect pest. Many laboratories throughout the world are engaged in research programmes aimed to obtain a more detailed knowledge of insect resistance; endorinology, insect defence and communication systems are also receiving considerable attention. Work in these areas may ultimately provide the basis for new, biologically sound control techniques that utilize insect hormones and pheromones or their analogues. Perhaps án even more promising avenue of investigation involves the examination of plants for naturally occuring secondary metabolite / series of synthetic compounds that may have insect repelling, insecticidal, antihormonal or antifeeding characteristics on which novel way to influence insect behaviour and development (or both) might be based. From a chemical view point our knowledge of many of these areas is still in an embryonic state. Moreover, the mechanisms of low insoluble

substances and their transport into the cell and further metabolism is a basic scientific problem to which world wide attention is attracted.

CIBC, CSIRO and USDA recommended biological control as a safe and environmentally acceptable means of controlling aquatic weeds. Development of potentials for biological control by utilising natural enemies from the neotropics and establishment of control agents to conduct host liberation studies will beimmensely useful. International conferences on water hyacinth held at RRL(H) in 1983 hold the view that management of water hyacinth would involve eradication of the plant wherever really necessary and to utilize to best advantage those methods which show promise to developing countries. It is this direction infrastructural facilities for rearing exotic insect pest, culturing fungal pathogens and testing weedicide formulations both under laboratory and field conditons physical and manpower facilities be strengthened so that feed back data obtained from the testing could serve as protocols for water hyacinth control under Indian conditions.

3.0 Programme for Seventh Plan

3.1. New Projects

A. IICB

i) Title: Neurobiology

Objectives: Studies on presynaptic events involed in neurotransmitter release from autonomic nerve terminals. To surveyiinborn errors of metabolism in tribal population in relation to mental retardation.

Fractionisation of various neuronal and glial population of brain cells using the hybridoma technology cloningof different types of brain cells.

Identification of biological function of the individual cell types namely those involved as drug and hormone receptors and in neurotransmitter release, neuropeptide biogenesis and various neurological disorders.

Alternative pathway of GABA oxidation. Biochemical mode of action of lithium ions.

ii. Title: Pharmacology

Objectives: Completion of studies on Parkinsonism including clinical investigations.

Studies on movement disorders other than Parkinsonism, namely tardive dyskinesia and Huntingtons Chorea including development of animal model and their therapy.

Bio-chemical and pharmacological characterisation of venoms from marine snakes.

iii. Title: Reproductive Biology

Objectives: Studies on potential antifertility drugs and their mechanisms of action. Corpus lutel studies in early pregnancy. Reproductive physiology in depth with development of assay kits for various trophic hormones and eventually immunological birth control. Mechanism of sperm maturation.

Hormonal regulation of reproduction in buffaloes.

iv. Title: Marine Biology

Objectives: Isolation and characterisation of bioactive substances from Sunderbans areas.

v. Title: Preventive vaccines for tropical diseases - parasitic, viral

Objectives: To prepare preventive vaccines for tropical parasitic and viral diseases.

vi. Title: Studies on Metabolic Inpairment

Objectives: To study metabolic impairments in diabetes, atherosclerosis and the role of shadow nutrients - e.g. Choline, inositol, lipoic acid and taurine.

B. NIO

i. Title: Utilization of plantation blooms in the Indian seas as a biomass resource for food, feed and drugs

Objectives: It is well known that phyto and zooplanton blooms occur in the Arabian sea and Bay of Bengal, after causing large scale mortality of fish and other marine organisms. The quantities of such blooms run into several million tonnes of biomass and this could be used for various purposes. (Such a thing has not been done so far anywhere in the world).

ii. Title: Deep Sea Biological Studies

Objectives: Deep Sea Biology is unknown in this country. The fauna of the deep sea is interesting and the opportunity of sea bed surveys in the Central Indian Ocean should be fully utilized for starting the programmes of great relevance for our understanding of the deep sea fauna and environmental aspects.

iii. Title: Antarctic Biology and Krill Studies

Objectives: With the 3rd Antarctic expedition successfully completing the establishment of a

permanent manned station at Dakshin Gangotri, there will be regular cruises into the Antarctic Ocean and land in future. This opportunity shall be fully utilized to start a vigorous programme for biological studies in this new area. This would also include biomass estimation of krill and its utilization for food and feed. This is a frontier area for R/D.

iv. Title: Marine Microbiological Studies
Objectives: Marine microbiological studies are in their infancy in India. It is well known that microbes play an important role in the regeneration of nutrients in the sea. It is estimated that oceans turn out about 740 billion tonnes of organic matter each year and it would be necessary to encourage a vigorous programme of research in this area, for understanding traphic food chains biodegradation and regeneration.

C. RRL (Hyderabad)

i. Title: Insect Pheromones as Population Regulators
Objectives: Insect suppression by behaviour controlling chemicals like pheromones and morphogenetic agents are useful in the integrated pest management programme and so the study will be undertaken in this line.

ii. Title: Biological Control of Weeds and Insects
Objectives: To study absorption of pollutants by the roots of aquatic weeds by electron microscopy. Field control of weeds by exotic and indigenous insects and pathogenic fungi. Laboratory performance of chemical fertilizer like mycorrhiza. Chemical examination of extracts of water hyacinth and its evaluation as insect controlling agents.

Linkages: In House- CSIRO, Australia, USDA(USA), CIBC, London and Trinidad.

Expected outputs: Control of abnoxious weeds and insect pests by natural enemies.

3.2 On Going

A. IICB

i. Title: Neurobiology

Objectives: Human foetal brain development, development of brain and action of hormones in the process, membrane biology of nerve terminals and mental retardation.

ii. Title: Pharmacology

Objectives: Studies on movement disorders autonomic transmission processes, venoms and toxins screening of drugs, their follow-up and elucidation of mechanisms of actions.

iii. Title: Reproductive Biology

Objectives: Search for antifertility and antispermatogenic agents and sperm maturation.

B. CDRI

i. Title: Biochemical studies in malaria

Objectives: Generating information regarding biochemistry of the parasite and the host with a view to design and develop better prophylactic and therapeutic agents.

ii. Title: Biochemical studies in filariasis and other helminth infection

Objectives: Generating information regarding biochemistry of host and parasite with a view to develop better prophylactic and therapeutic agents.

iii. Title: Biochemical studies in amoebiasis

Objectives: Generating information regarding biochemistry of host and parasite with a view to develop better prophylactic and therapeutic agents.

Expected output: Biochemical function of E. histolytica and free living amoeba. Elucidation of factors responsible for virulence and invasiveness of amoeba. Factors involved in encystment and excystment.

iv. Title: Biochemical studies on beta-Cell function in pancreas

Objectives: To investigate the role of beta cell of islets of Langerhans in the etiopathology of diabetes and to understand the role of insulinogens and anti-insulinogens.

v. Title: Ultrastructural and biochemical studies on Central nervous system

Objectives: Biochemical and ultrastructural studies on Central regulation of certain autonomic activities, electrophysiology of myocardium and changes in peripheral tissues in selected disease processes with a view to interpret drug action and to help in design of better drugs.

vi. Title: Ultrastructural and biochemical studies of the genital tract

Objectives: Ultrastructural and biochemical studies of the epididymis and female genital tract with a view to design agents for fertility regulation.

C. RRL (Hyderabad)

i. Title: Bioactivity and mode of action of insecticidal formulations and natural products

Objectives: Exploration of possible potential components from natural and synthetic sources for insecticidal, growth regulatory, chemo-sterilant and anti-feedant activities. Promising leads have been obtained in this area.

ii. Title: Insect Toxicology and Physiology with particular reference to hormones repellents and chemoreception

Objectives: To understand the mode and site of action of compounds and effects on insect systems against the structure activity relationship. The biochemical and physiological parameters are expected to show leads.

iii. Title: Biological control of water hyacinth

Objectives: To determine the natural enemies of fungal and animal origin from both indigenous and foreign resources. Important leads have been obtained in the area of exotic insect pest, fungal pathogens, weedicide formulations from RRL and analysis of water infested with water hyacinth.

4.0 S & T Sub-groups for emerging area,

A. IICB

i. Cell and protoplast fusion and transformation of yeast and plant protoplasts.

ii. Plant and animal tissue culture for production of pharmacologically active compounds.

iii. Development of new immunodiagnostic and immunoprophylactic methods using recombinant DNA and hybridoma technology.

iv. Cell surface membrane receptors in diseased conditions.

v. Neurobiological research tools for venoms and toxins.

vi. Advanced electrophysiological methodology for spinal and peripheral pharmacology and for neurophysiology.

vii. In vitro fertilization techniques and blastocyst culture.

viii. Techniques to induce forward motility of sperm.

B. RRL (Hyderabad)

i. Rearing of useful insects on specifically rich diet to get insect products of required variety.

ii. Insect pest resistance mechanism and management.

iii. Studies on insect - host - interaction.

C. NEERI

i. Genetic cloning and mutation techniques for structuring of microorganisms to degrade specific environmental pollutants.

D. RRL (Jorhat)

i. Basic biochemical studies - to elucidate the basic mechanisms of some biochemical and microbial processes existing in oil pollution control, secondary recoveries of oils, conversion of sterols to biologically active steroids and the production of industrial enzymes.

5.0 Infrastructural facilities to be created

Extension of Animal House (CDRI)

Green House (RRLH)

Electrophysiological Laboratory (RRLH)

Glass House (RRLH)

Microbiological Laboratory (RRLH)

Water tanks for field trials (RRLH)

Recovery facility (RRL Jammu)

6.0 FINANCIAL PROJECTIONS IN THE AREA OF APPLIED BIOLOGY (INCLUDING IMMUNOLOGY AND BIAGNOSTICS)

(Rs. in lakhs)

Sub - area	Laboratory		1985-86	1986-87	1987-88	1988-89	1989-90	Total
On-going and New								
Neurobiology Pharmacology Reproductive Biology	IICB IICB IICB	Ongoing	40.000	41.820	48.172	50.633	51.064	231.689
Biochemical studies in malaria	CDRI	Ongoing	108.470	111.630	115.160	101.350	107.040	543.650
Biochemical studies in filariasis and other helminth infections	CDRI	New	39.600	39.750	39.870	31.710	33.110	184.040
Biochemical studies in amoebiasis	CDRI							
Biochemical studies on beta-cell function in paucreas	CDRI							
Ultrastructural and biochemical studies on the genital tract	CDRI							
Ultrastructural and biochemical studies on entral nervous system								
Bioactivity and mode of action of insecticidal formulations & natural products	RRL(H)		11.000	11.000	11.000	11.000	11.000	55.000
Insect Toxicology and physiology with particular reference to hormones, repellents and chemo-reception	RRL(H)							
Biological control of water Myacinth	RRL(H)							
Biological Oceanography (Marine Living Resources)	NIO		68.00	65.000	62.000	68.000	67.000	330.000

Sub - area	Laboratory	1985-86	1986-87	1987-88	1988-89	1989-90	Total
New							
Insect pheromones as population regulator	RRL(H)	11.000	11.000	11.000	11.000	11.000	55.000
Biological control of weeds and insects	RRL(H)						
Genetic doning and mutation technique	NEERI	13.171	13.870	14.936	15.936	16.675	74.588
Microbial degradation of pesticides	NEERI						
Biological Oceanography (Marine Living Resources)	NIO	162.000	87.000	162.000	73.000	67.000	551.000
Evaluation of Natural products as RIS	RRL(Jm)	5.000	8.000	10.000	15.000	10.000	48.000
Basic biochemical studies	RRL(Jt)	6.000	8.000	10.000	10.000	10.000	44.000
SUMMARY							
Total:	On-going	227.470	229.450	236.332	230.983	236.104	1160.339
	New	264.771	173.620	253.806	156.646	147.785	996.628
GRAND TOTAL:		492.241	403.071	490.138	387.629	383.889	2156.967

Biotechnology

AREA: BIOTECHNOLOGY

Participating Laboratories

• Central Drug Research Institute, Lucknow	CDRI
• Central Food Technology Research Institute, Mysore	CFTRI
• Central Institute of Medicinal and Aromatic Plants, Lucknow	CIMAP
• CSIR Centre for Biochemicals, New Delhi	CFB
• Indian Institute of Chemical Biology, Calcutta	IICB
• Institute of Microbial Technology, Chandigarh	IMTECH
• National Botanical Research Institute, Lucknow	NBRI
• National Chemical Laboratory, Pune	NCL
• Regional Research Laboratory, Jammu	RRL (Jmu)
• Regional Research Laboratory, Jorhat	RRL (Jor)
• Regional Research Laboratory, Trivandrum	RRL (T)

Contents

		Page
1.0	Review of Progress and Achievements	130
2.0	Perspectives	137
3.0	S&T Programme for Seventh Plan	143
4.0	Financial Projections	161

1.0 REVIEW OF PROGRESS AND ACHIEVEMENTS

A. Central Drug Research Institute, Lucknow

i. Process for the production of l-ephedrine hydrochloride. The process has been licensed - production not available.

ii. Purification of cane molasses.

iii. Fermentation facilities with laboratory and pilot plant scale fermentors (upto 1500 lt.) with automation and control and other supporting and utility facilities created.

iv. Microbial stereospecific transformation of secodione (13-ethyl-3-methoxy-8, 14-secogona-1,3,5(10), 9-tetraen-14, 17-dione) to its optically active 17 β-hydroxy derivative, an intermediate in the total synthesis of estrone has been standardised in laboratory scale fermentor in an yield of 50%. Chemical conversion gives a mixture of α and β forms and the yield of latter is extremely poor. This process will be useful in the ultimate synthesis of contraceptive drugs.

v. An immobilized whole cell system has been developed which can be continuously used for the conversion of secodione to secol. This will lead to the development of continuous bioreactor using immobilized biocatalyst.

vi. 11α-hydroxylation of progesterone has been achieved in 65-75% yield using a fungal mycelium and high substrate concentrations in shake flasks. Fungal spores in immobilised form also bring about the reaction.

vii. Larger scale production of Bacillus thuringiensis spores (originally developed by VCRC, ICMR) has been undertaken for supply to Vector Control Research Centre, Pondicherry, for field trials as mosquito larvicide (collaborative project with ICMR).

3. Indian Institute of Chemical Biology, Calcutta

i. Liposomes have been used in tissue - targeted drug delivery system and as adjuvants in immunology. Liposome - entrapped drug has been successfully directed through specific ligands to hepatocytes for reversing artificially induced hepatitis.

ii. The Institute has evolved convenient immunoassay methods for the determination of estriol, HCG and prolactin.

iii. Experimental production of lectins from beans and plant seeds has been achieved in collaboration with industry. A modified method for the purification of human chorionic gonadotropin (HCG) from the urine of pregnant women has been developed.

iv. Carcinoscorpin, a sialic-acid binding protein, has been isolated from the haemolymph of Indian horseshoe crab and purified to homogeneity. It has been found to be useful for purifying biologically active sialoglycoproteins of diagnostic and therapeutic interest. The amoebocytes of this animal yield a lysate which has high sensitivity for detecting pyrogens in pharmaceutical and biological fluids, and has the potential for making handy pyrogen detection kit.

v. Physical mapping of cholera phase ø 149 is so far the only differentiating criteria between classical vibrios and its biotype el tor. This map ing has been carried out using restriction endonucleases, some of which were purified in the Institute.

vi. For developing an infrastructure for recombinant DNA research, the following enzymes have been pre ared: (a) ECoR1; (b) Bam H1 and (c) Pst 1. Besides, λ -DNA and the plasmid PBR 322 DNA, have also been isolated and purified.

vii. A plausible correlation between toxinogenicity of V. cholerae and several metabolic functions has been proposed.

viii. Interaction of temperate phages with the host in V. cholerae.

ix. Serodiagnostic methods for leishmaniasis and filariasis have been developed using homologous and heterologous antigens respectively in different immunodiagnostic methods, such as enzyme-linked immunosorbent assays (ELISA), countercurrent immunoelectrophoresis and rocket immuno-electrophoresis.

x. An antigen specific for pathogenic strains of human Neisseria has been characterized.

C. Central Institute of Medicinal and Aromatic Plants, Lucknow

i. Production of ergot alkaloids by fermentation on a laboratory scale.

ii. Isolation of two strains of C. purpurea for producing ergot alkaloids in submerged culture.

D. Institute of Microbial Technology, Chandigarh

New laboratory in the process of being established.

E. National Botanical Research Institute, Lucknow

i. Survey and cultivation of protein rich algae for maximum utilisation of solar energy (this has been in existence for many years and seems to generate little interest).

a. Standardization of methods for cultivating spirulina platensis in domestic raw sewage.
b. Standardization of a prototype unit with an exposed surface of $450m^2$.

ii. Tissue culture of economic plants.

a. An innovative method for germplasm preservation and establishment of tissue banks have been perfected.

b. Method for multiple differentiation of protocorms from tips of leaf and root of vanda trees and Rhynchostylis retusa from tips of leaf only of Dendrobium chrysotoxum. Technique to obtain transplantation success of in vitro regenerated plants of Simmondsia chinensia culture.

F. Regional Research Laboratory, Jorhat

i. High heat stable amylase (optimum activity at 80-85°C).

ii. Soil additives of microbial origin to increase the crop yield.

iii. Laboratory scale process for the production of heat stable α-amylase (level 10 lt. fermentor volume).

iv. Manufacture of bacterial products (BPPS) to increase the soil fertility (level 200 lt. fermentor volume).

v. Methods - Evaluation of soil fertility through the assay of soil microbial enzyme activity.

G. National Chemical Laboratory, Pune

Did not report

H. Central Food Technological Research Institute, Mysore

i. Five processes licensed for alcohol from tapioca, production of amylo glucosidase, pectinase, microbial rennet and glucose from starch.

I. Regional Research Laboratory, Jammu

i. A technology for the production of calcium gluconate (oral and injectable grade) by submerged fermentation process has been developed. The technology includes (a) development of a strain of Aspergillus niger with high specific conversion rates and stable physiology; (b) optimisation of physiochemical parameters for the consistent production; (c) design of the fermentation equipment with efficient and high oxygen transfer rates;

and (d) post-harvest technology for the isolation of the product.

The technology has been demonstrated at pilot plant scale to Punjab Fluconates and PSIDC through their consultants Ms. M.M. Suri and Mech-Chem. Consultants. Based on this technology, a plant with 200 MT/annum capacity is planned to be set up in Hoshiarpur.

ii. A study for the evaluation of intermediary metabolism in Candida lipolvtica growing at the expense of n-alkanes was carried out. The role of various intermediates of TCA and glyoxylate cycles for the regulation of production of citric acid by this organism was hypothesized on the basis of the levels of these intermediates at various selected stages of fermentation.

iii. Kinetics of glucose oxidase synthesis and its extraction from the cell mat of Aspergillus niger have been studied.

iv. A process for the 11α-hydroxylation of progesterone by a specially developed strain of Aspergillus ochraceus has been worked out.

v. Culture for Gibberellic acid with a capacity to produce 500-1600 mg. per litre GA_3 at laboratory scale was developed. Based upon this culture, technique for the production of Gibberellic acid by submerged culture was developed. On large scale, yields were 650 mg/lt. The process has been licensed to Ms. Chemosyn Research Centre, Vapi.

vi. No. of technologies offered: Four

a) Calcium gluconate
b) Citric acid
c) Gibberellic acid
d) 11-alpha hydroxy progesterone

vii. No. of technologies released: Three

a) Calcium gluconate
b) Citric acid
c) Gibberellic acid

viii. Processes gone into production

The plants for gluconic acid and gibberellic acid are under erection. The preliminary trials of gibberellic acid are successful. However, the products are expected to hit the market by December 1984.

ix. Technologies resulting in improvement of quality and productivity

a) Calcium gluconate

x. Nationally important infrastructure facility created

Most modern infrastructure has been created in RRL,Jammu. The glaxy of fermentors starting from 2 Lits. to 4000 Lits. have been acquired. The semi-commercial scale fermenter with a capacity of 4000 lits. has been designed and fabricated at the RRL, Jammu workshop. The microprocessor, computer controlled multi-parameter bio-reactor has been acquired. It is capable of data processing and data handling.

xi. Original Scientific Papers: Fifteen

xii. Papers presented at international conference: Two

xiii. Sponsored Projects taken up: One

xiv. General consultancy and advice: Three

xv. Cash flow from sponsored projects: Rs. 30,000

xvi. Cash flow from consultancy: Rs. 0.425 Lakhs.

xvii. Analytical & Testing: Rs. 0.02 Lakhs

xviii. Ph.D's: Two

J. Regional Research Laboratory, Trivandrum

Standardisation of biogas production utilising mixed substrates like coconut pith.

K. Centre for Biochemicals, New Delhi

i. Production of lectins (jointly with IICB). The technology has gone into production (production data not available)

ii. Technologies for the production of indigenous antigens and diagnostic kits have been perfected and offered for industrial exploitation. Pending their acceptance and industrial exploitation, CFB is making and offering this range of products as a service on a no prifit basis. During the period under review, CFB has trained 125 physicians in the field of allergy and immunotherapy used in the diagnosis and treatment of respiratory allergies leading to rhinitis, allergic asthma and allied diseases. As a result, 75 new allergy clinics have been opened in different parts of the country which has enabled extension of the benefit of fundamental research for better health care of masses.

At the instance of the Ministry of Health and the Association of Clinical Biochemists of India, CFT took on the task of bringing about standardisation and quality assurance in the field of clinical diagnosis involving body fluid investigations. A number of reference standards conforming to international norms have been made available to clinical pathology laboratories including tested reagents, control sera and reference sera. In addition a complete set of reagents in a kit form as per the norms recommended by WHO for developing countries have been standardised for 19 parameters of blood/urine analysis. The preparation of these kits and reference sera has been upscaled, costed and test marketed in the city of Delhi. The technology has since been released to one industry.

iii. During the period under review, CFB has added some 40 new chemicals to the list of products standardised and offered by it to several institutions in the country bringing up this list to 200 chemicals and 126 antigens. Among its users are prestigious research institutions in the country like BARC, TIFR, IISc (Bangalore), AIIMS, PGI (Chandigarh) over a hundred medical colleges, several agricultural universities, institutes under ICAR, CSIR, ICMR, DST, university laboratories, dairies, R&D departments of pharmaceutical industries and a large number of clinical pathology as well as allergy diagnosis laboratories.

0 PERSPECTIVES

Biotechnology is an interdisciplinary field. It includes Microbiology, Biochemistry and Biochemical Engineering. During the past two decades it has advanced due to breakthrough in genetics and molecular biology. They have dramatically enhanced the vast potential of biotechnology. The impact of biotechnology on various economic activities such as energy, environment, food, chemicals and pharmaceuticals is quite significant.

The state of the art in biotechnology and its relevance to applied research and industry in countries like India may be considered under five broad headings:

A. Fuel
B. Health
C. Food
D. Fertilizer
E. General

A. Fuel

As an alternative source of energy capable of replacing fossil fuels, biomass tops the list. Recombinant DNA technology may prove useful for the manufacture of cellulases. Work is already in progress in different laboratories in the world including India to clone the genes of cellular organisms involved

in biodegradation of cellulose. Exchange of genes between yeast and organisms that degrade cellulose is likely to lead to successful development of a process for the production of ethanol from agro waste. Equal emphasis should be given to the isolation of genetic material from organisms that convert decaying organic matter to methane, and transfer it to certain anaerobic micro-organisms that degrade cellulose. This transformation is likely to facilitate the direct and rapid conversion of cellulosic waste to methane. This will provide an environmentally clean fuel for industry and transportation.

B. Health

Production of drugs and vaccines

For the first time, with the aid of recombinant DNA technology substantial quantities of biologically active peptides have become available. Similarly it has been possible to produce human insulin in bioreactors. Thus this provides the possibility of developing naturally occurring biologically active products as chemotherapeutic agents. This was hitherto not possible as quantities to evaluate the action of these substances were not easily available.

Production of monoclonal antibodies

An antibody is an immunoglobulin that reacts or binds, with a specific foreign substance known as the antigen. This is the essential part of the immune system of animals. This antibody-antigen reaction is very specific-antibody recognises a single, small site or determinant on most antigens. Hence, antibodies can be used to identify and isolate minute quantities of material. Researchers have developed a way to make antibody producing tumour cells which will grow both inside animals, *in vivo* and in culture *in vitro*. These cells are called hybridoma because they are made by fusing a tumour cell with an antibody producing cell and are capable of synthesizing monoclonal antibody (single species of antibody that recognizes only one determinant). This is, however, in contrast to the immune response of animals which generally results in a population of antibodies with different antigenic specifications.

Monoclonal antibody is produced by hybridoma technique. Monoclonal antibodies have versatile applications e.g. for the diagnosis of a variety of bacterial, viral and protozoal diseases, for blood and tissue typing etc. Recent reports suggest that it is possible to produce monoclonal antibody against colon cancer. Potentially important medical application of this technology includes the production of a common vaccine for immunotherapy, cancer diagnosis and therapeutics. Besides, monoclonal antibody has many applications in agriculture (e.g. sexing spermatozoa , oestrus and ovulation detection, detection and concentration of mycotoxins, pesticide residues etc.) and Food industries (food product, nutritional quality, detection of pathogens, package security etc.).

Medical application of enzyme technology

Biotechnology utilizes capacities of human, animal, plant and microbial cells for human welfare. Enzyme engineering is one of the main themes in the field of biotechnology. There are several applications of enzyme technology in medical fields e.g. heparinase, urokinase, enzyme immune assay for free thyroxine, enzyme electrodes for simultaneous determination of creatinine and creatine in serum or whole blood etc.

Hence, emphasis should be given to develop this field e.g. immobilization of enzyme, determination of structure and function of enzyme, cloning of genes of enzymes in order to develop an economically viable process for the production of the enzyme.

Enzymatic peptide synthesis has unique application in the synthesis of human insulin, somatostatin, enkephalins, vaccines, growth factors etc. It is of considerable contemporary interest. The enzymatic peptide synthesis through a carboxy peptidase enzyme (CPD - Y) that has exipeptidase, esterase and amidase activities with broad specificaties and high stereo - selectivity has been successfully used in the conversion of porcine insulin to human insulin and preparation of Hepatitis B protective antigen etc.

Genetic engineering for drug production

It is possible to apply recombinant DNA technology for the chemotherapy of infectious disease. The production of certain drugs and specific enzyme inhibitors of medical interest at present produced by fungal or actinomycete culture can also be produced through a newly constructed bacterial strain. Bacteria have a short generation time as against fungi. Consequently there will be greater production of desired compound in unit time.

Plant tissue culture

Careful selection and manipulation may lead to quicker analysis of plant tissue cultures not only for alkaloids and cardiac glycoside content but also for the presence of antibacterial and antiviral agents, enzyme inhibitors and hormones and steroids.

In fact diagnostic enzymes, like phosphodiesterase from tobacco, are now commercially available. Also, some alkaloids and digoxin have been produced in good yields.

Tissue targetted drug delivery

Liposome entrapped drug has been successfully directed through specific ligands for the treatment of many diseases. Such specific drug delivery systems may eventually incorporate monoclonal antibodies and other highly specific agents.

C. Food

The food industry is mostly geared to the production, modification and improvement of biological materials. Thus it is reasonable to expect biotechnology to play a major role in this area. Fermented foods are quite common in one form or the other in all parts of the world. Use of Recombinant DNA technology, thermostable enzymes, enzyme cloning, genetic manipulation of microbial and plant cells and the use of plant cell tissue culture, will be helpful in food production and processing.

D. Fertilizer

The most important area under this heading is the biological nitrogen fixation. Many laboratories all over the world are already involved in this particular project which so far is nowhere near solution.

E. General

Instrumentation

Computation in biotechnology - Computers and related software systems have become necessary tools for storage, retrieval, manipulation and analysis of information in molecular biology. Current application of computers to biotechnology research may be divided into the following broad classes:

a) Data collection, assembly, storage, retrieval
b) Nucleic acid and protein sequence analysis
c) Restriction map generation
d) Simulation of molecular processes and experiment planning and debugging.

In future, computation is expected to play an important role in fermentation technology e.g. use of intelligent encyclopedia, design aids for scale-up etc.

Bioelectronics

In this field biosensors are probably themost advanced area. The salient feature of most biosensors is the physical proximity between the sensor (an enzyme) and the transducer (an electrode, a thermistor or a transistor). This makes the system both rapid and highly sensitive. Enzyme thermistors have variety of uses in clinical practice e.g. measurement of ascorbic acid, chloesterol, glucose and urea. Another application of the system is thermometric

enzyme linked immunosorbent assay system, or TELISA. Also, on-line, continuous analysis in the fermentation processes may be one of the most important application of enzyme thermistors.

Developments in the field of bioelectronics formed a major point of discussion at the "Biotech 83" conference held at London in May 1983.

0 S & T PROGRAMME FOR SEVENTH PLAN

.1 On-going Projects

A. Central Drug Research Institute, Lucknow

Sub-Area : Fermentation Technology

a. Microbial transformation of steroids:

(i) Conversion of 13-ethyl-3-methoxy-8, 14-secogona-1,3,5 (10),9-tetraene-14,17-dione to its 17-beta-hydroxy derivative using submerged fermentation as well as immobilised whole cell technique;

(ii) 11-alpha-hydroxylation of progesterone using submerged fermentation as well as immobilized spores;

(iii) 1-dehydrogenation of steroids employing whole cells as well as enzymes;

(iv) 17-alkyl side-chain cleavage of phytosterols employing submerged fermentation and immobilized whole cells.

b. Production of alcohol using non-conventional resources/ method:

(i) Direct conversion of cellulose to ethanol by genetically programming an ethanol-producing yeast or bacterium to degrade cellulose to alcohol;

(ii) Production of ethanol by immobilized whole cells.

c. Production of Bacillus thuringiensis spores for use as larvicidal agents, modified formulations thereof to improve dispensibility.

d. Isolation, characterization and classification of R-plasmids with a view to setting up a plasmid reference centre (ICMR sponsored project).

e. Maintenance and taxonomic studies of microbial strains.

B. Indian Institute of Chemical Biology, Calcutta

(i) Immunodiagnosis, immunoprophylaxis of bacterial, parasitic and viral diseases.

(ii) Development of recombinant DNA and hybridoma technology.

(iii) Utilisation of animal and agricultural residues for making high-valued products.

(iv) Use of liposomes as drug-delivery agents.

(v) Radioactive imaging of body organs.

(vi) Development of oral vaccine for cholera using recombinant DNA technology.

(vii) Cloning of toxin and peptidoglycan genes. The cholera toxin genes cloned so far do not exerete the toxin molecules indicating membrane involvement in the process. Attempt will be made to clone genes coding for peptidoglycans along with the toxin genes to examine whether expression of toxins is possible for use as a vaccine strain.

(viii) Cloning of recombinational genes of V. cholerae utilizi clones from the gene bank and analysis of rec functions using rec E. coli cells.

(ix) Analysis of error prone DNA repair mechanisms in V. cholerae and possible mutagenesis.

(x) Development and standardization of enzyme immunoassay techniques for various drugs and hormones and immuno-diagnosis for amoebiasis, pregnancy.

(xi) Development of pyrogen testing kit.

(xii) Development of radiopharmaceuticals for body organ imaging for diagnostic purposes.

(xiii) Development of process for the saccharification of cellulosic residues and wastes, and utilization of inulin reserves of plants for making fructose.

(xiv) Studies on human erythrocyte specific lectins.

(xv) Isolation and purification of sialic acid binding lectin on a larger scale and elucidation of its structure-function relationship.

(xvi) Search for specific recognition signals on cell surfaces of host macrophages andinvading Leishmania donovani.

(xvii) Targeted drug-delivery system for Kalaazar using macrophage-membrane receptors.

(xviii) Immunodiagnosis and immunoprophylaxis of visceral leishmaniasis using recombinant DNA and hybridoma technology

(xix) Investigation of surface antigens of Neisseria gonorrhoea and Vibrio cholerae.

C. Central Institute of Medicinal and Aromatic Plants,Lucknow

(i) Upscaling of the production of ergot alkaloids in saprophytic culture (should be linked with CDRI F.T. plans)

(ii) Improvement of medicinal and aromatic plants through (a) Protoplast culture, (b) Protoplast fusion, (c) Genetic manipulation in protoplast culture,

(d) Production of active constituents in submerged culture.

D. Institute of Microbial Technology, Chandigarh

Production of Extra Cellular Cellulase(s) by Truly Cellulolytic Fungi (with Special Emphasis on the Molecular Cloning of Genes of Fungal Origin Involved in Biodegradation of Cellulose)

Gene expression and its regulation in eucaryotes is one of the most important and fascinating branches of modern molecular biology. The importance of the study of the synthesis and regulation of cellulases, a typical inducible extracellular 'Multienzyme Complex' produced by the simplest eucaryotes (fungi) should be emphasised for its potential significance in studying energy problems. However, knowledge of the biosynthesis of cellulase(s) and its regulation(s) is still poor. Recent advancement in recombinant DNA technology has opened up a new vista in the field of molecular biology. With the help of this gene cloning technology and variety of methods involved in recombinant DNA research, one can get some definite answers regarding the expression and control of different genes involved in biodegradation of celluloses by the fungi.

It is now well recognised that enzymatic saccharification is a promising new method for the conversion of cellulose into glucose, a source of food and chemicals. However, the economics of enzymatic saccharification of cellulose rely substantially on the costs associated with enzyme production. To make this project economically viable, one will have to develop a cheaper method for the production of cellulases which may be possible by cloning the gene(s) involved in cellulose breakdown with a suitable vector in an appropriate host.

Under this programme, it is proposed to investigate the following:

(i) Cloning of cDNA(s) from the isolated mRNA(s) of different extracellular cellulolytic enzymes produced by M. phaseolina.

(ii) Using these cDNA(s) attempts will be made to prepare genomic library with the help of λ and M13 bacteria phages.

(iii) Attempts will be made to subclone or to clone cDNA(s) (prepared from mRNA(s) of fungal cellulolytic enzymes/ genomic cDNA with the aid of the hybrid plasmids in yeast as the host. It is to be noted that our main objective is to utilize cellulose as the new material for the production of ethanol. Hence, emphasis will be given to modulate yeast in such a way that this ethanol producing microbe can ferment cellulose directly.

E. National Botanical Research Institute, Lucknow

(i) Survey and cultivation of protein-rich algae for maximum utilization of solar energy.

Development and production of blue-green algae Spirulina platensis in sewage for animal feed.

In the seventh plan chemical and microbiological characteristics of algal biomass produced in sewage system will be examined.

Feeding experiments will be undertaken to test suitability of sewage grown spirulina as a supplement to poultry feed.

Basic physiological and genetic studies will be undertaken.

Linkages/users: Farmers, Poultry Industry, Animal Husbandry.

(ii) Tissue culture of economic plants.

In vitro proliferation of flowering plants as also medicinal plants.

Tissue culture of important tree species and other economically important plants.

Linkages/users: Cultivators, Forest departments.

F. Regional Research Laboratory, Jorhat

(i) Microbial response to biodegradable pesticides in cultivated soils.

Information about the microorganisms responsible for increasing soil fertility will be gathered. For this, soil microorganisms from various cultivated soils will be isolated and characterized and preserved in a bank.

Soil biochemicals such as organic acids, growth-promoting substances, sugars, vitamins, antibiotics and enzymes will be studied from the point of view of plant growth promotion.

The interaction of pesticides and chemical fertilizers will be studied to understand the effect of these xenobiotics on certain important microbial functions.

Plant physiological studies will be carried out with respect to growth through specific bacterial products.

G. Regional Research Laboratory, Jammu

(i) From diosgenine compound S triacetate is obtained. Deacetylated compound S is obtained microbiologically. Itis planned to standardise and upscale the deacetylation process and evolve a method for 11β - hydroxylation of compound S.

(ii) Exploratory work on microbial cleavage of side chain in sterol and its conversion to estrone.

(iii) Production of Ergot alkaloids by saprophytic culture

May be taken up jointly by RRL, Jammu and CIMAP and use should be made of fermentation facilities at CDRI.

H. National Chemical Laboratory, Pune

(i) Genetic Engineering for cellulase gene transfer, pentose fermentation, ethanol tolerance, stress resistance crops.

(ii) Enzyme and microbial technology for cellulose utilization continuous fermentation of molasses to ethanol in immobilized yeast cell reactors. Continuous biomethanation of effluents.immobilized industrial enzymes. Thrust basic areas of molecular enzymology and evolutionary biology.

(iii) Tissue culture for micropropagation of superior plants. Gene expression in plant cells molecular basis of differentiation and somatic hybridization.

(iv) Specialised culture collection of industrial micro-organisms.

I. Central Food Technological Research Institute, Mysore

(i) Glucose isomerase production and immobilization of enzyme continuous alcohol production, cellulosic waste for production of alcohol organic acid and glycerides.

(ii) Giberellic acid by solid state fermentation. Development of new strains of yeasts to tolerate high alcohol concentrations to tolerance of high temperature and capable of hydrolyzing starch.

(iii) Newer streptomyces strains for hydrolyzing hemicelluloses to produce glucose isomerase and to develop multiple immobilized enzyme systems for sequential enzymatic reactions.

(iv) Technology of fat from cellulosic waste.

(v) Pretreatment of foodgrains with enzymes to reduce energy in cooking.

J. Regional Research Laboratory, Trivandrum

(i) Utilization of locally available starchy substrates for bio-fuels andbio-chemicals.

(ii) Rapid ethanol fermentation by immobilized yeast cells.

K. Centre for Biochemicals, New Delhi

(i) The laboratory programmes of CFB are aimed at improving the availability of reagents and chemicals required for research in all areas of biotechnology so that it has a strong infrastructural base.

(ii) In an effort to meet its objectives, CFB has taken up research and development programmes in different areas of activity like immunology, diagnostics, microbiology, genetic engineering, enzymology, bioorganic chemistry, lipids, biochemicals from waste etc. Some technologies like lectins and diagnostic kits have been offered to industry. In view of urgent requirement of scientists a number of products are routinely made and supplied by CFB pending their transfer to industry.

2 New Initiatives/Areas/Rural Development Etc.

A. Central Drug Research Institute, Lucknow

(i) Microbiological/enzymatic synthesis of ampicillin from penicillin-G using free and immobilized systems.

(ii) Biochemical engineering studies of fermentation processes:

a) diffusional and rheological characteristics of biological systems with a view to optimizing design of bioreactors;

b) development of mathematical models with a view to study process kinetics, mass and heat transfer phenomena.

(iii) Development of clinical test strips for sugar, urea, lactose by application of immobilized enzymes.

(iv) Use of hybridoma and recombinant DNA technology

(in parasitic infections and infectious diseases) characterisation and production of antigens of a sexual and sexual stages of malarial parasites of human filarial worms and of Entamoebia histolytica for production of immunodiagnostic reagents and for vaccines using hybridoma and recombinant DNA

technologies.

B. Indian Institute of Chemical Biology, Calcutta

(i) Cloning of phage ø tRNA genes for characterization of phage specific tRNA and processing of the multimeric tRNA precursors.

(ii) Analysis of gene regulation in Vibrio cholerae using recombinant DNA technology.

(iii) Analysis of chromosomal and plasmid DNA replication in Vibrio cholerae.

(iv) Application of tissue culture in the breeding of new species plant development of plant tissue culture systems.

(v) Development of seed monitoring technology by the use of monoclonal antibodies against plant pathogens.

(vi) Molecular cloning of coagulogen and carcinoscorpin of horseshoe crab.

(vii) Development of targeted drug-delivery systems for leukaemia and hepatoma and use of liposomes as adjuvants.

(viii) Construction of improved strains for fermentation of cellulosic hydrolysates to alcohol.

(ix) New sub-groups for new emerging areas

(a) Development of preventive vaccines for tropical diseases - parasitic, bacterial viral.

(b) Studies on metabolic impairment e.g. diabetes, atherosclerosis and the role of shadow nutrients e.g. choline, inositol, lipoic acid and taurine.

(x) Infrastructure to be created for this area

(a) Ultracentrifuge
(b) Liquid scintillation counter
(c) Amino acid sequencer and
(d) DNA sequencer

Central Institute of Medicinal and Aromatic Plants, Lucknow

—

C. Institute of Microbial Technology, Chandigarh

(i) Synthesis and cloning of yeast pyruvate decarboxylase and alcohol dehydrogenase genes into bacteria.

It is now a well established fact that by appropriate genetic manipulation using recombinant DNA technique, an organism can be tailered to produce substances usually otherwise produced or synthesized by another organisms. The advantage of this approach is the inexpensive production of such vital substances and in large quantity for commercial exploitation.

(ii) The aim of this project is to transfer the genes of yeast coding for pyruvate decarboxylase and alcohol dehydrogenase into an anaerobic non-alcohol producing bacterium enabling the latter to produce alcohol from pyruvate. The advantage of this approach is that bacteria having short generation time (15-30 minutes) as against yeast (3-4 hours) will grow much faster, thus producing more alcohol in a unit time than yeast. Also, by introducing multicopy plasmid into bacteria containing the yeast genes would further increase the

ability of bacteria to produce more alcohol by self-induction of other steps by bacteria itself. The approach would involve both environmental adaptation and genetic manipulation.

Under this programme it is proposed to investigate the following:

a. Adaptation of bacteria to alcohol tolerance

b. Purification of enzymes and preparation of antisera

c. Isolation of mRNA

d. Synthesis and cloning of cDNA

e. Shot gun cloning of pyruvate decarboxylase and alcohol dehydrogenase genes of yeast

(ii) Microbial resources including gene-pool assets

Acquisition of essential microbial cultures and development of a culture bank to a maximum of 500 cultures (bacteria, actinomycetes, yeasts and fungi) and their maintenance, preservation storage and retrieval techniques appropriate to the strains.

Maintenance of the plasmid λ phage vector systems or cell line - viral vector systems.

Identification and taxonomic positioning of the desired microorganism.

Strain improvement through appropriate gene manipulation, mutagenesis, directed insertions, regulation perturbations, (overall general area: general microbiology, biochemistry, process and product - microbiology and biochemistry, microbial genetics,

biomass generation, microbial ecology, aerobic stationary and anaerobic process).

(iii) Molecular Biology and Genetic Engineering

- Optimisation of existing and generation of new technique for gene splicing, training of middle level scientists to handle different techniques.

- identification of potential-vector systems in yeasts, streptomycetes and methanogenic systems, biochemistry of the macro-molecules and restriction mapping, sequencing etc. (overall : donor-systems, vector-systems, donor-vector, vector-recipient linkage systems, enzymology, stability of the hybrid duplexes).

(iv) Bioreactors

- to serve the needs of microbiology and molecular biology areas.

- to optimise the process upto 100 litre level in order to provide an insight into the critical variables involved.

- to study within the limits of the reactor systems available, reactor design parameters (overall : process design, product recovery, upscaling, mathematical modelling, bioreactor design and materials of construction).

(v) Documentation and Inrormation transfer

- to scan the literature, patents and processes concerned with the projects being taken up by different groups and update their start-off points to avoid duplication and facilitate rapid generation of new information and optimisation of processes.

- to plan nucleation of the envisaged computerised information transfer system (overall: library, documentation, information retrieval, reprographic and photographic facilities).

(vi) New sub-groups for new emerging areas

a) Microbiology and Cell Biology

b) Molecular Biology and Genetic Engineering

c) Bio-engineering and process optimization

d) Genetic stocks of cultures and cell lines

(vii) Infrastructure to be created

Setting up of the main campus of the Institute. Procurement of basic equipment required for R & D purposes.

National Botanical Research Institute, Lucknow

D. Regional Research Laboratory, Jorhat

(i) Improvement in the production of ethanol

The objective of the present investigation is (i) to develop technology for the production of ethanol containing at least 10-12% in the fermentation broth with a fermentation efficiency of 90-95% in the first phase to meet the immediate demand, (ii) to develop a strain which can produce alcohol more than 12% and (iii) to develop a process for the production of ethanol using immobilized yeast cells.

Specific aspects:

1. Ethanol production (10-12%) from molasses using high alcohol producing yeast.

2. Application of immobilized yeast technology for continuous alcohol production.

3. Fluidized bed yeast for continuous alcohol production.

4. Strain improvement for better alcohol production using new technique like Protoplast fusion in yeast.

National Chemical Laboratory, Pune

E. Central Food Technological Research Institute, Mysore

(i) Giberellic acid by solid state fermentation.

(ii) Development of new strains of yeast to tolerate high alcohol concentration, high temperature and capabilities of hydrolyzing starch.

(iii) Newer streptomyces strains for hydrolyzing hemicellul... to produce glucose isomerase and to develop multiple immobilized enzymes system for sequential enzymatic reaction technology of fat from cellulosic waste.

(iv) Pretreatment of food grains with enzymes to reduce energy in cooking.

F. Regional Research Laboratory, Jammu

New Sub-groups

(i) Fermenter design: RRL has the infrastructure available for redesigning of conventional fermenters so as to develop a combination bioreactor which can provide a very high mass transfer coefficient, better mixing with lesser power inputs and lesser evaluation of heat

It is proposed to take up a joint collaborative projec on fermenter design development which will go in a lon way to cater to the needsof fermentation industry in this country.

(ii) Search for new antibiotics: It is proposed to take up a programme on the new generation antibiotics producti and their subsequent modification. Besides, the chemi modification of the various known aminoglycoside antibiotics will be undertaken in collaboration with the natural product chemistry department with a view to obtain a less toxic morepotent modified aminoglycos as a semi-synthetic chemotherapeutic agent of chemical utility.

(iii) Enzymes: It is proposed to take up a project on the development of process for the production of amylase, amyloglucosidase, glucose isomerase, glucose oxidase and invertase.

(iv) Clonal propagation of forest trees by tissue culture:

In this programme, it is proposed to take up mass scal propagation of following sps.

Pinus radiata
Pinus longifolia
Pinus gerardiana

Rutin bearing Eucalyptus sps.

(v) Bio-utilization of lignocellulosic waste of the region

This project is a coordinated project between CFTRI, NCL and RRL, Jorhat. Only preliminary identification of wastes has been carried out and screening will be completed by 1985. Project will be taken up in the seventh Plan period.

(vi) Infrastructure: A proper uptodate and multipurpose recovery unit for post fermentation harvest is proposed to be designed and fabricated.

. Regional Research Laboratory, Trivandrum

(i) Development of alcohol tolerant yeast and rapid ethanol fermentation flavour enhanced fermented products from tapioca.

(ii) Development studies on high frotose syrup.

(iii) Retting of cocconut husk and other fibres using specific microflora.

H. Centre for Biochemicals, New Delhi

(i) Over the years, the Centre for Biochemicals has acquired expertise in upscaling and costing of bench scale methods and test marketing to evaluate user acceptance. The Centre proposes to use this expertise in evaluating newer bench level processes developed in the field of biological sciences and thus work as an interface between the laboratory and industry.

(ii) New sub-groups for new emerging areas:

In order to attain the objectives set, it is proposed to expand the base of CFB in two main areas of activity and provide it with substantial infrastructure by way of space, manpower and equipment.

a) To standardise the preparation and upscaling of restriction enzymes oligonucleotides, linkers and other fine chemicals.

b) To standardise methods for the preparation of antibodies using modern technologies such as hybridoma.

c) To standardise diagnostic methods based on immunological techniques.

(iii) Sub-group II

Proving projects and services.

To take up bench scale methods standardised in different laboratories for upscaling and studying their acceptibility by the end user. At this stage, technologies may either be offered to industry or exploited by the Centre and the products offered as a service to scientists

(iv) Infrastructure to be created for this area:

The CFB has been operating a small area on the premises of V.P. Chest Institute, University Campus, Delhi. Since occupying this space its staff has trebled and its activities have grown substantially. It's growth has come to a standstill because of space limitation and it urgently needs to have a campus of its own including laboratories and housing. The Management Committee has approved of its expansion plan which includes its space, manpower and equipment needs until the end of the growth plan which is reflected in the financial projects

4.0 FINANCIAL PROJECTIONS

(Rs in lakhs)

Participating Laboratories	1985-86	1986-87	1987-88	1988-89	1989-90	Total
On-going						
CDRI	29.610	32.320	35.140	34.070	36.140	167.280
IICB	50.000	94.500	96.750	89.000	70.000	401.150
CIMAP	6.918	0.926	0.935	0.944	0.977	10.700
NBRI	7.435	7.645	7.750	6.860	7.100	36.790
RRL-Jorhat	3.500	4.500	4.500	5.500	5.000	23.000
NCL	130.000	200.000	250.000	220.000	200.000	1000.000
CFTRI	20.000	20.000	20.000	20.000	20.000	100.000
RRL-Jammu	20.000	17.000	19.000	19.000	19.000	94.000
RRL-Trivandrum	13.500	14.400	10.000	8.000	10.000	57.100
CFB	56.376	56.168	37.960	32.072	36.533	219.109
	337.339	447.459	482.335	436.346	405.650	2109.129

(Rs in lakhs)

Participating Laboratories	1985-86	1986-87	1987-88	1988-89	1989-90	Total
NEW						
CDRI	19.770	21.780	23.290	21.260	22.420	108.520
CIMAP	14.412	6.767	41.827	1.887	2.507	67.400
IMTECH	47.600	56.700	64.000	70.000	84.700	323.000
PRL-Jorhat	3.500	4.500	4.500	5.500	5.000	23.000
RRL-Jammu	15.000	18.000	20.000	29.000	40.000	122.000
CFB	18.866	23.166	28.809	29.415	30.560	130.816
	119.148	130.913	182.426	157.062	185.187	774.736

(Rs in lakhs)

Participating Laboratories	1985-86	1986-87	1987-88	1988-89	1989-90	Tota.
Infrastructure						
IMTECH	582.000	586.000	188.500	190.500	44.000	1591.000
NBRI	7.000	7.500	8.000	8.500	9.000	40.000
RRL-Jorhat	6.000	6.000	8.000	8.000	10.000	38.000
RRL-Jammu	5.000	9.000	10.000	6.000	-	30.000
CFB	210.744	108.338	94.565	40.199	15.683	469.529
	810.744	716.838	309.065	253.199	78.683	2168.529
Total						
Ongoing	337.339	447.459	482.335	436.346	405.650	2109.129
New	929.892	847.751	491.491	410.261	263.870	2943.265
Grand Total	1267.231	1295.210	973.826	846.607	669.520	5052.394

Cellular and Molecular Biology

A A: CELLULAR & MOLECULAR BIOLOGY

Participating laboratories

Centre for Cellular & Molecular Biology
Hyderabad ... CCMB

Indian Institute of Chemical Biology
Calcutta ... IICB

National Botanical Research Institute
Lucknow ... NBRI

CONTENTS

		Page
1.0	Review of Progress and Achievements	166
2.0	Perspectives	176
3.0	S&T Programme for Seventh Plan	181
4.0	Financial Projections	206

1.0 Review of Progress and achievements (1980-83)

1.1 CCMB

1.1.1 Number of papers

Number of scientific papers published .. 84

Number of papers presented at international conferences .. 29

1.1.2 Novel proteins from seminal plasma: Five novel proteins with interesting biological functions have been isolated from bovine seminalplasma. Seminalplasmin is one among these which is a potent antimicrobial protein. It inhibits both transcriptional and translational functions. Detailed investigations on the protein chemistry of seminalplasmin, antiseminalplasmin (a protein which is antagonistic in function to seminalplasmin), two proteases and a ribonuclease also from bovine seminal fluid have been carried out in the laboratory.

1.1.3 Control of cell division and malignant transformation: Arising out of a comprehensive and detailed survey of the vast literature on the problem of the control of cell division and transformation, a model for the process has been proposed. This model regards the control of uptake of essential nutrients into a cell as an important step that can be modulated by a cellular factor.

In normal dividing cells this factor, I, would regulate the entry of nutrients such that these cells may be termed phenotypically I^+. On the contrary, malignantly transformed cells

would not only phenotypically $\underline{I}^-$ but would be unable to revert to the $\underline{I}^+$ state. Experiments in the laboratory have indicated that a protein indeed exists in normal cells which regulates the entry of essential metabolites; this protein appears to occur in unaltered state that is biologically inactive in transformed cells, such as those of the Zajdela ascitic hepatoma.

1.1.4 Tumour immunology: A tumour specific transplantation antigen (TSTA) has been isolated and purified for the first time from a rat ascitic tumour, which breaks new ground in terms of its application in the control of the disease and in basic investigations in studying the biological role of TSTAs and in unravelling the structure of this important class of tumour antigens. The success in developing the methodology and in purifying the TSTA makes it possible to examine the mechanisms of elucidation of immune response to tumour cells.

1.1.5 Studies on Tumour Cell Surfaces: Studies on the cell surface properties of the ascitic tumour have revealed notable differences in the glycosylation of the proteins present in the transformed cells. The specificity and the basis of this phenomenon and its importance in the control of division and social behaviour of the transformed cells are under investigation.

1.1.6 Molecular biology of tumour viruses: Valuable insights have been provided into the structure-function relationship of the enzyme reverse transcriptase which is a key enzyme for malignant transformation by RNA tumour viruses and also used routinely now in molecular cloning. The findings on the template primer and primer binding sites of reverse transcriptase, and of DNA polymerases have given a wealth of information on the catalytic domain of the enzyme. Investigations of different inhibitors to enzyme have also shown ways by which the viral function can be inhibited, controlled or modulated. The findings on the copying of Z-DNA by reverse transcriptase and other DNA polymerases have significant implications on the possible control functions by such structures.

1.1.7 Compartmentalisation of DNA polymerase: Work on DNA synthesis in animal cells has led to the discovery of DNA polymerase associated with elements of the cell and valuable insights into the compartmentalisation of DNA polymerase. The compartmentalization is a function of the specific stage of cell division cycle. This observation has opened up new avenues of research of basic significance.

1.1.8 Physical biochemistry and biomolecular spectroscopy: The newly developed non-invasive tool photoacoustic spectroscopy (PAS) has been used in specific problems in chemistry and biology: (i) The kinetics and thermo-chemistry of the solid state photopolymerization of diacetylenes to produce polydiacetylenes have been delineated. The conformation and orientation of the polymer on the monomer crystal have

been established using *in situ* irradiation in the PA spectrometer. (ii) The photodamage that is caused to vitamin B_1 (thiamine) and its derivatives has been monitored by PAS in the solid state. (iii) Of greater interest is the successful application of the PA method in analysing the status of the endogenous hemin, the malaria pigment and on the mechanism of action of quinoline class of antimalarial drugs in the parasite which has been delineated from PAS data. The PA method also is able to distinguish readily between drug-resistant and drug-sensitive parasites, thereby offering the potential of screening infected erythrocytes or blood smears directly by the PA method.

1.1.9 Membrane models and membrane active proteins: In order to study membrane interactions and macromolecular interactions in membrane bound environments preparation, characterization and detailed studies on micellar and reverse micellar assemblies were undertaken. In depth studies were carried out on the properties of proteins encapsulated in the inner water pool of reverse micelles. The use of such reverse micellar assemblies as models for membranes has been a pioneering effort.

Work done has provided proof for the oil-drop model of these aggregates and has shown that the amount of water inside the micellar phase is indeed very small. These studies have accentuated the essential hydrophobicity of micellar and membrane interiors and has set right some of the recent controversial arguments about this problem.

1.1.10 Protein conformation and folding: The pathway by which a totally unfolded protein molecule adopts its native conformation, and the attendant structural and kinetic aspects, are of importance, since in the living cell, a newly biosynthesised protein adopts its biologically functional form extremely rapidly. In order to understand the mechanisms underlying this phenomenon, the enzyme RNAase A has been studied. These studies have revealed that this enzyme is able to readily fold back to its native state, with some specific intermediate states in the process. Similar work on the enzyme carboxypeptidase has shown that the folding process occurs rapidly and is guided by structural intermediates that may be referred to as microglobules of domains.

1.1.11 Signal peptide and membrane translocation of proteins: It has now become known that a protein is able to translocate from its site of synthesis to its site of abundance by traversing across membranes, and the information for it to do so is contained in terms of a signal sequence which causes the protein to embed itself in the membrane first. At this stage the signal sequence is enzymatically hydrolysed, causing the protein be released from the membrane to go to its target site. In an effort to understand the role and function of the signal peptide sequence in proteins, work has centred around the actual chemical synthesis of known signal sequences, a study of the interaction of these sequences with biological membranes, and coupling the sequence with a known

protein to study its transport behaviour. The signal sequence of lysozyme has been totally synthesised and its interactions with liposomes and bilayers has been studied in detail. Current efforts are towards coupling the signal sequence with lysozyme and investigating the properties of the resultant molecule.

1.1.12 Molecular endocrinology: A study on the mechanism of action and modulation of the effect of hormones in target tissues has been undertaken. The techniques of electron microscopy and immunochemical and biochemical methods have been used in the estrogenic stimulation of ovariectomised. This stimulation leads to mitotic activity and cornified and stratified epithelium. The keratin polypeptides isolated after hormone administration have been carefully analysed to study estrogen induced keratinization.

1.1.13 Genetics of osmoregulation in E.coli: The phenomenon of osmotic tolerance in certain strains of the microorganism E.coli is a puzzling one and current efforts in the laboratory are directed towards answering this problem. Strains of the microbes that exhibits osmotic sensitivity have been isolated and a genetic map worked out. The gene or the gene cluster responsible for such osmoregulation in the strains are being identified and their expression investigated.

1.1.14 Encapsulation of nucleic acids in liposomes: It has been shown that, when large molecular weight RNAs are encapsulated in liposomes, a part of the RNA is exposed on the liposome surface and can be degraded by RNAase A, which does not affect the RNA which is inside the liposome. This is the first demonstration of its kind and could be important in devising strategies for using liposomes as carriers of nucleic acids into cells of higher organisms.

1.1.15 Restriction' ribonucleases and proteases: It has been shown that isolated liver cells and bovine spermatozoa carry RNAases on the cell surface. This is the first definitive demonstration of the presence of cell surface RNAases and could be important in devising strategies for putting foreign nucleic acid into cells.

We have demonstrated the presence in liver of two RNAases, one which cleaves homologous RNA but does not attach E. coli RNA and the other which cleaves E. coli RNA but not homologous liver RNA. In both cases, no acid-soluble fragments are generated and the limit digest appears to consist of discrete products which can be separated by polyacrylamide gel electrophoresis under appropriate conditions. These two enzymes, along with RNAase isolated from bovine seminal plasma, are, as of today, the only known candidates for what one might call 'restriction' RNAases, that would recognise a sequence of at least three nucleotides everywhere it exists in the RNA molecule.

Similarly, the two proteases already mentioned elsewhere in this brief review, isolated from bovine seminal plasma, would appear to be the only candidates known for 'restriction' proteases, that is, proteases that would recognise a sequence of at least two amino acids and cleave any protein where this sequence exists and is available.

1.1.16 Technologies for resource exploration/ exploitation: The process for the isolation and purification of the antimicrobial protein seminalplasmin has been standardised and handed over to IDL Chemicals, Hyderabad, on a contract basis for their preparation of the protein. This protein occurs in and is isolated from the seminal fluid of bulls.

1.1.17 Infrastructural facilities of national importance: The electron microscope facility that has been set up and is operating at CCMB provides both in-house research needs and facilities for electron microscopic work for other laboratories and universities in the country. CCMB had assisted over 20 external users with the electron microscope facility. It has also conducted 4 workshops and intensive schools on the principles and applications of electron microscopy in biology during the period 1980-83. The organisation of such courses and workshops is part of the charter of the CCMB and has helped scientists from universities, national laboratories and other R & D organisations.

1.1.18 Indicators to services provided: CCMB has provided assistance with their instruments and facilities to various universities, national laboratories and R & D institutions in the country for their

research programmes. The services provided by CCMB to external users is of the order of about 30 working days to over 20 users per year on an average.

1.1.19 Education and training indicators: 5 Ph.Ds awarded and 4 Ph.D theses submitted.

1.1.20 Training courses organised:

i) Seminar on 'Applications of scanning electron microscopy in biology', October 1980, 2 days, 40 students.

ii) Workshop on 'Applications of electron microscopy', September 1981, 5 days, 12 students.

iii) Workshop on 'Cryobiological techniques in electron microscopy', November 1981, 3 days, 8 students.

iv) Workshop on 'Ultrastructure of the nucleus and chromosomes', October 1983, 7 days, 8 students.

v) Workshop on 'Biological applications of radioisotopes' (jointly with Hyderabad Science Society, Hyderabad) December 1982-January 1983, 8 weeks, 10 students).

1.2 IICB

1.2.1 Mechanisms of extrathyroidal thyroxine biosynthesis have been elucidated.

1.2.2 A new type of peroxidase inhibitable by chloride ions has been found in the mitochondrial membrane of gastic cells.

1.2.3 The role of erythropoietin in lipid biogenesis of RBC membrane has been demonstrated.

1.2.4 Glucagon has been shown to stimulate alanine amino-transferase, a gluconeogenic enzyme.

1.2.5 Mechanisms of repair of DNA damage induced by UV and photodynamic treatment in Vibrio cholerae have been worked out in detail and their relation with toxinogenicity has been established through isolation of radiation sensitive mutants from hypertoxinogenic strains. Such mutants have been isolated for the first time.

1.2.6 Repair of membrane damage in buffer has been demonstrated in Vibrio cholerae for the first time.

1.2.7 Early and late 149 specific protein and phosphate repression of phage growth have been demonstrated.

1.2.8 Specific antagonism of cholera toxin by Cibacton Blue in vitro has been demonstrated.

1.2.9 Classical phage 149 has been shown to synthesize phage specific tRNA molecules.

1.2.10 Possible existence of SOS functions has been demonstrated in V.cholerae for the first time.

1.2.11 A number of cases of mucopolysaccharidosis and phenyliketonuria were identified on the basis of enzyme deficiency studies. These investigations would be useful for the genetic counselling of parents at risk.

1.2.12 It has been demonstrated that MAO types can be selectively inhibited in the brains of laboratory animals so that they can be used as models for neuropharmacological and psychopharmacological studies.

1.2.13 It has been shown that one of the major effects of thyroids hormones during brain development is to regulate the biogenesis of tubulin required for the formation of cellular processes.

1.2.14 Protoplasmic estrocytes representing the bulk of brain cells, have been isolated, purified and their membrane markers characterised.

1.2.15 Important mechanisms of neurotransmitter release process have been unearthed by discovering the existence and functional role of presynaptic muscarinic and PG receptors on cholinergic nerve terminals.

1.2.16 Role of motoneurons in tremorogenesis was elucidated through biochemical confirmation of Renshaw cell inhibition.

2.0 Perspectives

National Needs and International Trends

a) Developments in the last ten years have made revolutionary progress in modern

biology making it possible to ask questions of fundamental importance in biology and do things in the way of applications, hitherto unimaginable. These developments portend major changes in several human endeavours - in industry, agriculture, medicine and in commerce - which are potentially capable of changing the life style of human societies in the coming decades.

b) Unlike other developed technologies, the developing area of biotechnology is inextricably linked with continuing understanding of basic biology which alone can keep up with on-going progress. This situation also leads to the question of future requirement of manpower capable of making use of the new technology for the needs of the country. As has happened in the early days of the development of nuclear technology, scientists who have taken part in creative research in an advancing area are the ones who can provide effective leadership even in applications later on. Equally important is the requirement for providing facilities and opportunities at the present time for frontline research in modern biology for promising young scientists of our country who should be able to make major contributions and establish world leadership at least in some of the fronts. Advancing the frontiers of knowledge in this manner in one of the most exciting areas of present day science will certainly go a long way in providing competent manpower requirements for

future and also in the building up of national confidence.

c) In all the developed countries such as USA, Canada, UK, all the Western European countries, Australia and Japan the importance of basic research in the area of cellular and molecular biology is well recognised and there are first rate institutions, apart from universities which are geared precisely to carry out work in this area. This situation is obtained in the USSR also and there is increasing realization of its importance in the East European countries. It is worth mentioning that in the "Five Year Outlook on Science and Technology 1982" submitted by the US National Science Foundation to the Members of the Congress in September 1983 eight points of growth have been identified. Out of this total of eight, four points of growth belong to modern biology, and one half of the document is devoted to discussions on areas in cellular and molecular biology.

d) Although in the applications of different kinds of technology priorities vary from country to country in new and developing technologies and in basic research the major problems to be tackled are essentially similar. It is, therefore, in order to mention some of the areas of work that are recognised as important the world over.

With the development of the capability to handle the genomes of complex organisms

using techniques of modern biology, major advances are expected in our understanding of the structure and expression of genes in animals and in plants. Such advances have already been made in our understanding of the organization of genes and in realizing the importance of jumping genes or transposons. Recombinant DNA technology and hybridoma methods have paved the way to understanding how the diversity of antibodies are brought about and how the immune system functions. Besides opening up possibilities for asking significant questions of basic importance in areas such as the molecular basis of evolution, development and differentiation (i.e. how from a single fertilized egg cell a whole animal develops by well orchestrated gene expression and how different kinds of cells acquire specialised functions) present developments have also led us closer to understanding basic events responsible for diseases such as cancer enabling us to look for ways and means of prevention rather than control. The discovery of the existence of cellular oncogenes while providing better understanding has at the same time raised several questions about their function during normal development as well as in events leading to cancer.

There have also been major progress in our understanding of receptor sites of hormones and neurotransmitters. Recognition of signals and response to signals such as visual images by the eye or recognition of smells by receptors in the nose, among several other even more subtle recognition processes, in a living organisms form an

important element in the functioning of a multicellular living organism. The receptors of such signals are shown to be proteins. Understanding of the receptor sites, changes in conformation that the receptors undergo on binding to hormones or neurotransmitters and the interaction of the complexes with membranes are not only major tasks in the coming years, but they are also expected to provide guidelines for the control of diseases and the design of new drugs. Likewise the study of neuropeptides and neurochemistry will also be an important area of future research.

Molecular biology and molecular genetics of plants is yet another area that needs major attention. Study of the structure and function of the genes present in nuclear DNA, mitochondrial DNA and chloroplast DNA, study of vectors capable of introducing new information in the DNA, and understanding the secrets of how some plants can be generated from single cells while others cannot be - at least at the present time - are again tasks of fundamental interest. Such understanding is expected to help develop means for developing crop plants resistant to drought or salinity or diseases - essential requirements for increased production and for bringing marginal land into cultivation.

In the above brief-perspective for basic research in cellular & molecular biology, other than occasional mention, no account has been given to the important areas of application of biotechnology.

3.0 S&T Programme for the Seventh Plan

3.1 CCMB

3.1.1 Molecular biology of plant cells

i. The mechanism of loss of totipotency in cereal crops

These studies would entail investigations of molecular events at the level of proteins, messenger RNAs and DNA during specific kinds of plant differentiation in culture which lead to concommittant loss of totipotency. This project would have a tremendous potential impact on our ability to grow and manipulate cereal crops in culture. The results of this study could be extrapolated to our understanding of the phenomenon of totipotenciality in higher animal cells.

ii. Plant cell surfaces

It is also proposed to undertake a study of cell surfaces of plants as well as protoplasts and their role in various cellular processes. The cell surface antigens of higher animal cells, like the major histocompatibility complex proteins, the organ differentiation antigens and tumor antigens, are increasingly known to play very significant roles in cell to cell interaction, recognition, transport of nutrients and differentiation. The proposed project in plants is being undertaken on the premise that cell surface antigens of plant cells also must be involved in a large number of cellular interactions, e.g. plant-pathogen interaction, interaction of legume roots with

the nitrogen fixing bacteria, organ genesis and differentiation and pollen-stigma interactions.

3.1.2 Molecular genetics of mycobacterium leprae

A project that would be undertaken during this period is to establish a plasmid-genome library of the leprosy bacillus M. leprae in Eschericia coli. The unique gene sequence of M. leprae would then serve as specific hybridisation probes in conforming or refuting the identity of alleged cultures of M. leprae. Such probes would also be useful in hybridisation experiments in situ to study the pathogenesis and natural history of leprosy.

Another important question that this project will address is: can the genes of M. leprae (a gram-positive acid-fast organism) be expressed in E. coli (a gram-negative host)? If the answer is yes, it would offer a convenient handle for studying the molecular genetics of M. leprae, after the identification of specific genes or gene clusters by complementation in E. coli.

3.1.3 Molecular Basis of Development, Differentiation, Regulation of Cell Division and Malignant Transformation (Mammalian Systems)

i. Early mammalian development and differentiation

In order to investigate molecular events governing differentiation and early mammalian development and to examine possible relationship of such events to malignant transformation

it is proposed to undertake studies on teratocarcinoma cell cultures of human and mouse origin. The system is a good one for studying in vitro differentiation. The study envisages raising of monoclonal antibodies to the differentiated and non-differentiated cells and the use of the reagents as to study the regulation of cell cycle. We also plan to use somatic cell hybridization and microcell hybrids to study regulation and molecular probes to study tissue specific expression.

ii. Cell cycle mutants

Although cell division is a fundamental characteristic of living organisms, an understanding of the control of cell division is far from satisfactory. We plan to undertake investigation on basic molecular event involved in cell division with a view to determine what makes a cell to go into division cycle or into resting stage. With thermosensitive selection procedure for isolating mutants that has been developed in the study of slim moulds, we plan to isolate mutants that are blocked at a specific stages in cell cycle and identify molecular triggering mechanism(s) controlling cell division.

iii. Chromatin structure and its activation during gene regulation

(a) Studies with specific gene probes

Chromatin needs to be 'activated' in a specific manner prior to the transcription of a gene. Although there are techniques available to distinguish silent and activated chromatin, the process of activation is poorly understood. This is a central problem to determining the events involved with tissue-specific gene regulation during embryonic development. It is proposed to study the mechanism of chromatin activation in various tissues of adult and developing rat with specific gene probes from rat liver. Total chromatin will be isolated from rat liver at various stages of development, treated with enzymes that preferentially degrade active chromatin and then probed with cDNA fragments corresponding to genes specifically expressed inadult liver, for example, albumin and tyrosine amino transferase. Attempts will also be made to isolate chromatin enriched for the above genes (using specific restriction enzymes) and study the effect of cytoplasmic factors which may induce specific activation of chromatin.

(b) Role of high mobility group (HMG) proteins in chromatin structure

The HMG proteins are a group of non-histone chromosomal proteins implicated

in diverse phenomena, such as cell cycle regulation and chromatin activation. It is proposed to study these proteins at two levels (a) to clone specific HMG genes and study their expression as a function of embryonic development, and (b) to use spectroscopic and immunological techniques to study the interaction of HMG proteins with chromatin elements. These studies should provide new information about an important group of proteins involved in eukaryotic gene expression.

iv. Molecular endocrinology: Mechanism of hormone action and modulation of effects of hormone on target organs

In order to study the regulation of hormone expression and their modulation effects on target organ we have been analysing keratin polypeptides synthesied in vaginal epithelial cells under the influence of estradiol in comparison with epidermal keratin which is not influenced by estradiol. During the seventh plan period, it is planned to study the effects of sex steroids on thymus, bones and catridges. The study would be extended in order to understand the effects of growth hormone on tissues from immature and mature animals and man. This study would help in understanding the phenomenon of the stopping of growth upon the onset of maturity.

v. Localisation of cell surface antigens

Cell surface antigens play a vital role in processes such as the delivery of drugs, and the mechanism of action of drugs, toxins, hormones and other biologically important substances. The chemical constituents of cell membranes *in situ* are currently being studied at the Centre by developing new probes. By using hybridoma technology, newer methods in protein-protein conjugation techniques and X-ray microprobe analysis, we plan to quantitate cell surface antigens under normal, pathological and experimentally altered physiological conditions.

vi. Oncogenes

Within the last five years there has been tremendous progress in our understanding of the role of cellular oncogenes and its role in malignant transformation as well as its possible role during development. Over expression caused by changes in control function, expression in tissues different from those in which such genes have a normal role in development, expression of mutated cellular oncogenes and expression of multiple oncogenes have all been invoked as possible mechanisms triggering malignant transformation. However, several important questions concerning malignant transformation and development remain unsolved and the study of oncogenes opens up new avenues for seeking answers to such questions. In the seventh five year plan we propose to undertake the study of

oncogenes from the Zajdela Ascitic Hepatoma - a rat tumour on which we have carried out a considerable amount of work and also human mammary tumours. For human tumours we plan to work with Parsi tumours as they have three times as much mammary cancer incidence compared to other Indian communities. Also, of all the cancers reported in Parsi women as much as 50% are mammary cancer. It is expected that use of such tumours would be advantageous in cloning the oncogenes and studying their expression.

vii. Tyrosine kinases of importance in carcinogenesis

Mechanism of transformation

Transforming genes (oncogenes) of some RNA tumour viruses code for a protein product which shows tyrosine specific protein kinase activity. The tyrosine-specific protein kinase activity of the oncogene product is believed to be responsible for cell transformation by these viruses. Available evidence suggest that the primary action of the transforming agents occur at the level of the plasma membrane. It would therefore be important to analyse the phosphoproteins containing phospho-tyrosine from the plasma membranes of normal and transformed cells. Those proteins which are specifically phos-phorylated in transformed cell membranes

but not (or less) phosphorylated in normal cell membranes could represent the primary target of tyrosine specific protein kinase coded by viral oncogenes. Characterisation of these phosphoproteins and tests for their functional properties would be carried out which is expected to provide insight into the mechanism of cell transformation by the group of viruses whose oncogenes code for tyrosines specific protein kinase.

viii. Regulation of heat shock response

It has been shown that when cells are exposed to elevated temperatures, they respond by inducing the synthesis of a small number of new proteins while the synthesis of most other proteins is repressed. Preliminary observations in the Centre have indicated that rat ascitic tumour cells respond to heat shock by synthesising tumour-specific heat-shock proteins. The proposed study envisages examination of the basic mechanism of the regulation of heat-shock protein synthesis and the role of tumour-specific heat-shock proteins in protecting the cell against heat-shock.

3.1.4 Membranes

(a) Bacterial toxins - peptides from the pathogen staphylococcus aureus

Several bacteria elaborate specific proteins and peptides that invade other cells causing

cell lysis. Some examples are the cholera toxin and the diphtehria toxin. Work has recently been on a study of the detailed mechanisms of action of four protein toxins generated by the pathogenic organism S-aureus. The aim of the project is to delineate all the molecular steps involved in the elaboration, targetting, interaction with the host membrane and the membrane lytic event caused by these four toxins. Initial attempts will be to characterise these proteins and study their mechanism of action by a variety of physico-chemical methods such as high resolution multi-dimensional nuclear magnetic resonance (NMR) spectroscopy and electron microscopic methods and also biochemical methods.

(b) Transfer of proteins across membranes

The chemical synthesis of some eukaryotic signal sequences have been undertaken with a view to understand the role of signal sequences in the transfer of proteins across membranes. The synthesis of the signal sequence of chicken lysozyme has already been completed. The synthesis of 'modified' signal sequences of lysozyme and those of lambda receptor and lipoprotein (E.coli outer membrane proteins) are expected to be completed shortly. Fluorescence studies have shown that the hydrophobic fragments of the

signal sequence of lysozyme interact with model membranes and are located at the hydrophobic core of the lipid bilayer.

In the coming years, it is proposed to study the interaction of synthetic signal sequences with the various sites of processing of secreted proteins like E. coli membranes and microsomal membranes. It is expected that these studies would help substantially in understanding the process of transfer of proteins across membranes at a molecular level.

(c) Investigation of fatty acid acylation sites of proteins

Many membrane-associated proteins such as the hemaglutin of influenza virus or the transfer in receptor have fatty acids covalently linked to them. These sites are near the membrane-spanning regions of these proteins. This post-translational modification is necessary for certain functions of these proteins, such as membrane fusion. Investigation of the acylation sites should help in understanding how acylation confers certain membrane-modifying properties to these proteins.

3.1.5 Olfaction: Development of a very sensitive bio-assay system

Current methods of bioassay using immunochemical and in particular the enzyme-linked immunoassay (ELISA) are able to go down to ferritomolar level. However, when one wishes to study even lower levels of certain specific molecules such as those involved in the olfactory response, visual response and similar neurophysiological phenomenon, the development of even more sensitive assay systems becomes of the greatest importance. The centre has been working towards the development of such assay systems since the last two years and a considerable amount of preliminary work has been carried out. The methods are based on a solid phase ELISA system that would use at once dual specificity antibodies where the detection system would be changed to electroantennograms that would respond to signal molecules such as pheromones. The basic logic of the method has been worked out and it is expected to take the specificity to even higher levels, to the extent of several hundred molecules. Simultaneously, a neurophysiological study, including the chemical aspects, concerned with individual-specific odours and olfactory response in animals, would be taken up. This project involves the characterisation of new specific odours in the mouse system and aims at an exploration of the possibility of whether the MHC recognition system is genetically linked to the odour base system.

3.1.6 Protein Chemistry

(a) Dynamics

The role of amino acid side-chains on protein

conformations and the pathways of folding of a protein chain are of continuing interest since the pioneering studies of G N Ramachandran. The major challenging questions that we wish to study are concerned with (a) the pathways and time periods involved in a newly synthesised protein chain in the cell adopting its biologically active conformation (b) special features of the disulfide bridge in terms of its conformation and redox properties (c) hydrophilic to lipophilic transition occurs in some water soluble proteins that bind to membranes e.g. toxins, complement fragments, and (d) development of simple algorithms that would predict the three-dimensional structures of globular proteins from their amino acid sequences.

(b) Caseins

While it is known that the family of proteins, i.e. alpha, beta, gamma, kappa, etc., caseins occur in milk as an aggregated or micellar entity with interesting functional properties, the nature and role of the micelle is still an enigma. It is known that the micelle is solubilised by kappa-casein, which is a phosphoglycosialo protein. A study of the nature of the casein micelle and the localisation of kappa casein will be initiated using immunochemical techniques and electron microscopy as well as an analysis of the detailed primary structure and the location

of sugar moieties in kappa casein. The programme envisaged here is expected to provide information about the nature of the forces involved in the stability and the size of the micelle and the function of the micelle in milk.

(c) Mechanism of action of bacterial and yeast RNA polymerases

DNA dependent RNA polymerase is one of the most important enzymes involved in the regulation of gene expression. Many important questions regarding its interaction with template or substrates or its mode of action from both kinetic and thermodynamic points of view are not yet properly understood. The main objective of this project is to design experimental approaches to answer several questions such as:

(i) The role of the sigma subunit in promoter selection and the minimum length of the reading frame necessary before the turnover of the sigma factor.

(ii) The role of intrinsic metals of RNA polymerase in gene regulation, and

(iii) The promotion of specific in vitro transcription in yeast class II genes.

3.1.7 Synthetic peptides and oligonucleotides

(a) Synthetic peptides as immunological tools

Many chromatin associated proteins like histones or the high mobility group proteins are very poor antigens, presumably due to

their highly conserved nature. Antibodies to these proteins would be useful in studies on chromatin structure. It is proposed to explore the possibility of using synthetic peptides corresponding to sequences of these proteins to raise antibodies which would cross react with the parent proteins.

(b) Oligonucleotides

Chemically synthesised oligonucleotides of defined sequences have a very important utility in vital aspects of the studies of genes. They are used as probes in the isolation of desired genes and m-RNAs, as linkers in splicing gene fragments, as primers for sequencing DNA, as adapters for insertion of genes into plasmids and other vectors. In addition they are necessary as models for physiochemical investigations of nucleic acid conformations, protein-nucleic acid and drug-DNA interactions. A programme has already been initiated for these studies.

3.1.8 Theoretical studies on biological macromolecular interactions

(a) Protein structure

Methods will be developed to predict the three dimensional structures of globular proteins from their sequences. The specific aim is to develop simple algorithms which can work on

micro-computers and which can be used by biologists. While the structures that will be predicted by this method would be essentially static in nature, it is also important to study the dynamic aspects of protein structures such as mobility, temperature factors, solvation etc. In order to achieve this end, work will be initiated using the methods of information theory, graph theory, systems theory and interactions, catalytic surfaces, and stability parameters in order to get an understanding of what and how a given biological system decides on the structure of a particular molecule to perform a given function.

(b) DNA sequence data analysis

Available sequences data from prokaryotic systems will be analysed along with amino acid sequences of the corresponding proteins with a view to predict the amino acid sequences directly from the DNA sequences. This type of analysis will be useful in understanding how coding frames are selected in nucleic acids. Likewise, an analysis of RNA and DNA sequence is expected to be of interest in the study of problems of evolution. The methods used in this study will also be helpful in the prediction of the nucleic acid structures and their interactions with proteins and drugs.

(c) Theoretical studies on biological evolution

An important problem in biological evolution

and the origin of life is the transition from chemical to biological evolution and the origin of the first biological cell. Work has already been initiated in the laboratory towards the study of this problem by simulation techniques and by the study of interaction energy and distance dependent condensation of ensembles of proteins, nucleic acids and lipid molecules into aggregates and a possible compartmentalisation of these aggregates into small viable volumes. Immediate future efforts will be to study this process using theoretical methods for developing potential energy surfaces for such condensations.

3.1.9 OTHER AREAS IN WHICH WORK WOULD BE CARRIED OUT BY NEW GROUPS

When new group leaders join the Centre, they will initiate activities in themes of their interest which would follow the philosophy of choice of projects outlined above. It is obviously not possible to define these areas now.

3.1.10 Perspectives and new initiatives on Ongoing problems

Several of the ongoing research activities at the CCMB are based on broad (important) themes, on which further work will continue for the next several years, so that the questions addressed can be answered to satisfaction. Some of the

areas are listed below (this list is only indicative and not exhaustive, as it is difficult - even impossible - to make precise predictions in the field of basic research).

a) Seminal plasma proteins - their structure, functional modes, distribution and localisation, special properties and the molecular biology of their synthesis and processing.

b) Malignant transformation: Regulation of control of cell division.

c) Differentiation and Development: Study of events controlling these phases.

d) Tumour immunology - tumour specific dtransplantation antigens, cell surface studies.

e) Non.invasive spectroscopy - photoacoustic methods, fluorescence and magnetic resonance spectroscopy in vivo.

f) Protein chemistry - mechanism and kinetics of protein folding, aggregation and interactions of proteins, protein-nucleic acid interactions, phase separations.

g) Theoretical biology - protein conformations, DNA and RNA sequence distributions, computer methods.

h) Membranes and cell surfaces - membrane models, membrane protein interactions, protein transport across membranes.

3.2 IICB

3.2.1 (a) Analysis of error prone DNA repair mechanisms in V.cholerae and possible mutagenesis involving isolation of repair deficient mutants and recombinant DNA technology (Biotech. Mol Biol).

(b) Replication of cholera phage 0149 DNA with a view to elucidating its differential role in infection of classical Vibrios and its biotype el tor (Basic). (Mol Biol).

3.2.2 Study of the molecular biology and characterization of economically important plant viruses particularly those affecting rice. These cause havoc in India and all over the 3rd world and nothing is known about these. (Biotech. Mol Biol).

3.2.3 Cytobiochemistry of growth factor receptors and studies on the steps involved between quiescence and mitogenesis (Basic) (Mol Biol).

3.2.4 (a) Purification and characterization of a factor from submaxilary gland which regulates estradiol formation in ovary (Basic).

(b) Investigation of the participation of a gastric peroxidases in HC1 formation (Basic) (Mol Biol).

3.2.5 Search for specific recognition signals on cell surfaces of host macrophages and invading Leishamnia donovani (Basic).

3.2.6 Isolation, purification, characterization and pharmacological studies of bioactive compounds from plant and marine products (Basic).

3.2.7 (a)Fractionation of various neuronal and glial population of brain cells using the hybridoma technology (Basic).

(b)Cloning of different types of brain cells (Basic).

(c)Identification of biological function of the individual cell types namely those involved as drug and hormone receptors and in neurotransmitter release, neuropeptide biogenesis and various neurological disorders (Basic).

(d)Studies on presynaptic events involved in neurotransmitter release from autonomic nerve terminals with a view to developing drugs against control and peripheral autonomic malfunctions (Basic) (Neurobiol).

3.2.8 (a)Alternative pathway of GABA oxidation (Basic).

(b)Biochemical mode of action of lithium ions (Basic).

3.2.9 Mechanism of sperm maturation (Basic).

3.3 NBRI

3.3.1 Biochemical and biophysical studies of the process of photosynthesis and nitrogen metabolism in plants

The understanding of the process of photosynthesis and nitrogen metabolism is important from the point of view of increasing yield, biomass production and control of growth and development of plants. In India, there are hardly six groups working in the area of photosynthesis and the country is deficient in trained and experienced scientists in this area. The primary objective of the project is to set up facilities to initiate work on basic research problems, such as, carbon and nitrogen metabolism in plants and chloroplast membrane function.

The work will concentrate on:

(a) Nitrogen-metabolizing enzymes involved in nitrate assimilation to aminotransferases responsible for the biosynthesis of different amino-acids; (b) CO_2-assimilating enzymes and their regulation; (c) functional aspects of the chloroplast membrane.

3.3.2 Molecular Genetics of Plants

During 7th five year plan, infrastructure required to undertake work on molecular genetics will be built up and work undertaken to study the nuclear and organelle genomes of plants. Special emphasis will be given to

opium poppy on which genetic work has already been done in this Institute. It is intended to study, as a first step, the expression of the chloroplast genome. Simultaneously work on simpler algal systems will be studied. As the expertise is acquired the group would undertake work on plant mitochondrial genome on which there is very little information. Besides, the establishment of a group in biochemistry will complement the activities in this area. However, the expertise and experience of the newly recruited people will determine the exact project work.

3.3.3 Physiology and genetic regulation of heterocyst differentiation, nitrogen fixation and ammonia metabolism in blue green algae

The blue-green algae are unique in that they have limited inorganic requirements for luxiuriant growth and fix both carbon dioxide and nitrogen at the expense of solar energy. Their contribution in nitrogen cycling and enrichment are well known and their successful utilization in agriculture can be achieved fully only when basic information regarding regulation of nitrogen fixation and ammonia assimilation is available.

The differentiation of heterocyst (*het*), nitrogen (*nif*) and ammonia formation in photoautographic blue-green algae are quite fascinating but full of technical limitations and, therefore, need basic studies. The main objective of the project is to dissect out of physiological and

genetic elements which control the expression of *het* and *nif* operon and ammonia assimilation in blue-green algae. With such information, the photosynthetic nitrogen-fixing potential of these organisms can be manipulated genetically and physiologically as a source of ammonia formation as such, or through immobilized enzyme technique.

Work will be undertaken on the following lines:

(a) Repression and depression of heterocyst and nitrogen-fixing genes under different experimental conditions.

(b) Isolation of different classes of mutants of *het* and *nif* genes, nitrate-nitrite reductase, glutanine synthetase, etc.

(c) Production of glutamine auxotroph and depressed *het* and *nif* strains with aerobic nitrogen fixation, even in the presence of extracellular nitrogen.

(d) Isolation of partially defective GS and suppressed inherent H_2-production so that most of the nitrogenase is utilized for nitrogen reduction and the strain may excrete ammonia under aerobic conditions.

(e) Identification of regulatory mutants of *het*, *nif* and *GS* operon, and to use these strains in construction of a system for production of ammonia *in vivo* or through immobilized enzyme technology.

3.3.4 Growth kinetics and physiology of Botryococcus

There is evidence that microalgae have contributed to the formation of hydrocarbons, such as, shales and oils, found in geologically recent and ancient sediments. The species of microalgae most directly implicated in geological hydrocarbon formation is Botryococcus braunii which has been the source of shale deposits, and at least some oil deposits.

Hydrocarbons, having a chain length of C_{15} to C_{33}, are producted by a wide range of species of microalgae. However, the percentage hydrocarbon composition of microalgae is low, ranging from 0 to 5% with an average of 1%. At present, it seems that there is only one exception described in the literature, which produces a larger proportion: the unicellular green alga Botryococcus braunii. During the exponential growth in cultures, the alga has been reported to have a hydrocarbon content of around 20%.

It has been suggested that Botryococcus, which has contributed to the world's hydrocarbon reserves, over a geological time scale, might be grown as a remarkable source of liquid fuel closely resembling crude oil. However, normally the growth of the alga in laboratory cultures as well as in natural environments is extremely slow. In order to exploit this organism for fuel production, therefore, it is essential to study its physiology to know that restricts its growth rate.

Growth characteristics of different growth states of Botryococcus will be studied in pure cultures, under controlled conditions. Chemical changes occurring during its growth will be investigated. The mineral requirement of the alga will be studied using different culture media under varying environmental conditions. Attempts will be made to reduce the generation time in order to increase the growth rate and produce pure blooms of the alga. Besides, physiological and genetical studies will be undertaken to find out the factors affecting the algal bloom.

3.3.5 Biological, biochemical and immunological studies on plant viruses

Ornamental and other economic plants are severely affected by viruses causing considerable losses. Although viruses affecting crop plants have been well studied, viruses affecting ornamental and forest trees have not been investigated in detail. Work at this Institute has resulted in isolation and purification of some of the viruses affecting flowering plants. However, these have not been thoroughly characterised. Some of these viruses are gemini viruses and their study is important as they could be used as vectors in genetic engineering.

The detection of viruses by serological methods possesses several advantages in studies of viruses and procedures for the same need to be investigated. Also there is a need for establishment of a sera bank for plant viruses.

The investigations on biochemical mechanisms underlying infection and resistance is important to understand the host and pathogen relationship. These studies are actively being pursued at the international level.

Biological studies would include isolation, identification and characterisation of suspected gemini-viruses which have recently gained world wide interest due to their possible use as vectors in genetic engineering. Besides, studies on weeds would be taken up to elucidate their epidemiological role in recurrence of viruses on economically important plants.

Biochemical studies proposed are:

i) Elucidation of the mechanism of pathogenesis induced by viruses by study of virus coded/ induced factors in intact system as well as in protoplast culture;

ii) Elucidation of the mechanism of both virus induced and chemical induced resistance in plants as well as in isolated protoplasts.

iii) Immunological studies would include development of rapid and sensitive serological techniques specific for different host-virus combinations and their subsequent use for identification and detection of viruses in infected plants.

Pathological studies at the cellular level will include the effect of viruses on different cell organelles and their impact on over all disease syndrome in different host-virus combinations.

FINANCIAL PROJECTIONS FOR THE AREA OF CELLULAR AND MOLECULAR BIOLOGY

(Rs. in lakhs)

	1985-86	1986-87	1987-88	1988-89	1989-90	Total
CCMB						
Projects						
Ongoing	85.96	107.60	127.20	142.80	154.40	617.96
New	128.94	161.40	190.80	214.20	231.60	926.94
New Infrastructure	534.50	488.00	336.00	287.00	286.00	1931.50
NBRI						
Projects						
New	44.56	28.90	23.29	25.73	22.57	145.05
New Infrastructure	9.50	10.00	11.00	12.00	12.50	55.00
Total	803.46	795.90	688.29	681.73	707.07	3676.45
Ongoing	85.96	107.60	127.20	142.80	154.40	617.96
New	717.50	688.30	541.09	538.93	652.67	3058.49

Drugs, Pharmaceuticals

Area : DRUGS AND PHARMACEUTICALS

Participating Laboratories

- Central Drug Research Institute
  Lucknow (CDRI)
- Centre for Biochemicals
  New Delhi (CFB)
- Indian Institute of Chemical Biology
  Calcutta (IICB)
- National Botanical Research Institute
  Lucknow (NBRI)
- National Chemical Laboratory
  Pune (NCL)
- Regional Research Laboratory
  Bhubaneswar (RRL-Bhu)
- Regional Research Laboratory
  Hyderabad (RRL-Hyd)
- Regional Research Laboratory
  Jammu (RRL-Jammu)
- Regional Research Laboratory
  Jorhat (RRL-Jor)

Contents

		Page
1.0	Review of Progress and Achievements	209
2.0	Perspectives	218
3.0	S&T Programme for Seventh Plan	226
4.0	Major Infrastructure Needs	233
5.0	Financial Projections	234

1.0 REVIEW OF PROGRESS AND ACHIEVEMENTS

1.1 A. Physical Output Indicators

1.1.1 Hard Outputs

		CDRI	IICB	NBRI	NCL
1. a)	No. of technologies in production	Cervical dilator, paracetamol, aminobutanol, dimethoxybenzimidazole (4)	-	-	Theophylline aminophylline/caffeine, Quinpyramine, Ibuprofen, Vinblastine/and Vincristine Vitamin B6 (5)
b)	No. of technologies offered/released	L-Dopa, Bumetamide, Primaquin, Furoic acid, Trimethoprim, Methylpiperazine, Lidamidine, Pralidoxime, Protein hydrolysate (9)	Improved methods for urea stibamine, pentamidine (2)	-	Salbutamol, terbutaline, metaprolol, atemolol, verapamil (5)
c)	Products/processes released to industry but not exploited	Bumetamide, Primaquin, Furoic acid, Trimethoprim, Lidamidine, Pralidoxime, Protein hydrolysate(7)	-	-	-
2.	Products/processes that have gone into production	Aminobutanol (1)	-	-	Theophylline etc., Quinpyramine, Ibuprofen, Vinblastine and Vincristine, Vitamin B6 (5)
3.	Technologies that have gone for social welfare	-	-	-	-

		RRL (Bhu)	RRL(H)	RRL (Jammu)	RRL (Jorhat)
1.	a) No. of technologies in production	-	Cloribrate, Diazepam, Chlordiazep-oxide Tromaril (4)	Progesterone	Chloroquin (1)
	b) No. of technologies offered/released	Solasodine, 16-DPA, hecogenin, Methaqua-line (4)	-	16-DPA, 16-DHA, Testosterone, Progesterone, 17-alpha-hydroxy-progesterone, its acetate and cap-roate	-
	c) Products/processes released to industry but not exploited	-	-	16-DPA, DHA	-
2.	Products/processes that have gone into production	-	Tromaril (1)	Progesterone, Testosterone	Chloroquin (1)
3.	Technologies that have gone for social welfare	-	-	-	-

	RRL (Bhu)	RRL (H)	RRL(Jammu)	RRL (Jor)	CFB(Delhi)
4. Technologies that have helped in saving of raw material and/or other inputs	-	-	-	-	-
5. Technologies for saving of energy	-	-	-	-	-
6. Technologies for improvement of quality and productivity	-	-	-	Chloroquine (minimised No. of unit operations)	-
7. Technologies for national security	-	-	-	-	-
8. Technologies for resources exploration exploitation	Hecogenin from sisal waste, solasodine from S. khasianum (2)	-	-	-	-
9. National important infrastructural facilities created (April 80 - Dec. 83)	-	-	-	-	Facility for preparation and standardisation of allergens.

		CDRI	IICB	NBRI	NCL
4.	Technologies that have helped in saving of raw material and/or other inputs	-	-	-	-
5.	Technologies for saving of energy	-	-	-	-
6.	Technologies for improvement of quality and productivity	-	-	-	-
7.	Technologies for national security	-	-	-	-
8.	Technologies for resources exploration exploitation	Cervical dilator from psyllium husk (1)	Diosgenin from Kallstroemia pubescens	-	-
9.	National important infrastructural facilities created (April 80 - Dec. 83)	Primate House (capacity 900 monkeys), Additional Sophisticated Equipment in RSIC.	Electron microscope; NMR; Mass and ORD-CD spectrometers; liquid scintillation counter; amino acid analyser; HPLC; spectrophotofluorometer.	-	-

.2. SOFT OUTPUT:

i) CDRI

Basic Research:

Central adrenervic, dopaminergic, bistaminergic, tryptaminefgic and muscarinic receptors concerned with thermoregulation have been identified in brain of mastomys. A new experimental model has been developed for studying dopamine agonists and antagenists utilizing temperature changes in mastomys. Verapamil, a calcium antagonist, and proprenolol, a non-selective 3-adreneceptor antagonist, have been shown to possess marked protective effect on rabbit ischaemic myocardium; the mechanism of protective effect has been elucidated.

Applied:

Methods and techniques and services

Gugulipid(hypolipidaemic), a standard fraction from Commiphora mukul (guggul) resin, is in phase III clinical trial. It has shown good lipid and cholesterol lowering activity.

A new infiltration and spinal anaesthetic (Centbucridine) has shown good results in clinical trials.

A new neuroleptic (Centbutindole) is in phase II clinical trial; it is comparable to haloperidol and trifluperazine.

Curcumin (anti-inflammatory), colouring principle from turmeric, is in Phase II clinical trial; it has shown good results in rheumatoid arthritis; it is tolerated very well. Its efficacy is comparable to that of phenylbutazone.

A new antidepressant (Centpropazine) is in phase II clinical trial.

A new muscle-relaxant (Chandonium iodide) has been cleared by the Drugs Controller (India) for phase I clinical trial.

An analogue of metenkephalin has been synthesised which has 4000 times the analgesic activity of the present compound.

ii) IICB

Basic research

Total synthesis of four indole alkaloids carried out. Site of action of 2 antiparkinsonian drugs identified as peripheral. Scorpion venom proteins showed novel effects on membrane and can be used as neurological research tools. Aristolic acid showed potent antifertility effect.

Applied

iii) NBRI

Basic research

Applied:

Phermacognosy of 22 herbal drugs and ultramorphology of 15 drug species carried out. Twenty four compound drugs standardize

iv) NCL -

v) RRL (Bhub) -

vi) RRL (H) -

Basic research -

Applied:

Heterocyclic and open chain compounds have been synthesised and evaluated for biological activity.

vii) RRL (Jam.)

(i) Basic research - Mechanism of action of a number of drugs established. Anti-haemorrhagic activity was found to increase platelet count and thus megakaryocyte count in bone marrow, adding a new dimension to control of blood disorders. Leads have been obtained to explain the immune mechanism of some herbal drugs.

(ii) Specific antibodies developed for radio-immunoassay.

Applied:

Oxytocic action of vasicine established and synthetic analogues show bronchodilation activity. Synthetic stigenyl ketones have shown anti-inflammatory activity. Process for synthesis of TTA, an important intermediate for the production of corticosteroids, has been developed.

viii) RRL (Jor.)

Basic research:

Reaction of benzofurazon oxide with conjugated enamines gave new organic noxides.

Applied:

ix) CFB (Delhi)

Basic research:

Work done on assessing the quality of allergens using a novel method based on Fast Protein liquid chromatography technique has been reported to the Indian College of Allergy and Applied Immunology at their annual meeting in October, 1983.

Work done at this Centre on the charged serum lipid profiles in patients of asthma was also reported at this meeting.

Applied: Nil

	CDRI	IICB	NBRI	NCL	RRL(Bhu)	RRL(Hyd)	RRL (Jammu)	RRL (Jor)	CFB
SOFT OUTPUTS Contd.									
Publications Scientific Papers.	180		30			18	18	15	3
Technical Report.									
Papers presented at International conferences.	5		-			-	2		1
Surveys									one at 40 centres.
Sponsored Projects.									
a) Total number taken up	6		2			-	2		-
b) Total value of it (Rs. in laks)	1.5						0.30		-
c) Number completed	4					1	1		-
d) Title of the sponsored projects whose value exceed Rs.10.00 lakhs.	-								
Services provided indicators.									
a) Statutory services.	Assay of 200 sample of drugs.								
b) Others. Consultancy services (Number)							10		-
a) Feasibility reports.	55						-		-
b) Literature survey	-						-		-
c) Design engineering	-						-		-
d) Erection/commissioning of plants.	-						-		-
e) Assessment of corporate R&D programmes of the clien	-						-		-
f) A nalysis	-						-		-

	Laboratory	1985-86	1986-87	1987-88	1988-89	1989-90	Total
III. Infrastructure for the area							
	i) CDRI	18.00	18.00	16.00	-	-	52.00
	ii) IICB	30.00	20.00	80.00	23.00	20.00	173.00
	iii) RRL (Hyd.)	3.00	8.00	-	-	-	11.00
	iv) RRL (Jammu)	9.00	5.00	5.00	-	-	19.00
	v) RRL (Jorhat)	3.00	3.00	4.00	4.00	5.00	19.00
	vi) CFB (Delhi)	8.00	6.00	5.00	2.00	2.00	23.00
	vii) NBRI	5.97	7.00	7.50	8.00	8.50	36.97
IV. Total (I + II + III)							
	Continuing	206.16	224.95	211.57	160.15	153.53	956.36
	New	229.71	236.04	313.91	189.33	202.73	1171.72
	Total	435.87	460.99	525.48	349.48	356.26	2128.08

I. Sub-Area:	Laboratory		1985-86	1986-87	1987-88	1988-89	1989-90	Total
Development of new synthetic drugs	i) CDRI	Continuing	80.00	84.91	89.15	77.90	82.23	414.19
		New	41.00	42.46	44.57	38.96	41.12	208.11
	ii) RRL (Hyd)	Continuing	4.00	2.00	2.00	2.00	2.00	12.00
		New	11.50	2.00	2.00	2.00	2.00	19.50
	iii) RRL (Jammu)	Continuing	10.00	10.00	10.00	7.50	7.50	45.00
		New	7.50	7.50	10.00	10.00	10.00	45.00
	iv) IICB (Cal)	Continuing	3.50	7.60	8.00	7.50	6.00	32.60
		New	3.50	8.00	8.00	7.50	6.00	33.00
I. Sub-Area								
Drugs from natural sources	i) CDRI	Continuing	25.60	26.89	28.16	24.60	26.00	131.25
		New	12.80	13.45	14.08	12.31	13.00	65.64
	ii) IICB (Cal)	Continuing	4.00	8.00	8.30	8.00	6.80	35.10
		New	-	-	-	-	-	-
	iii) RRL (Hyd)	Continuing	4.00	2.00	2.00	2.00	2.00	12.00
		New	4.00	2.00	2.00	2.00	2.00	12.00
	iv) RRL (Jammu)	Continuing	10.00	10.00	10.00	7.50	7.50	45.00
		New	7.50	7.50	10.00	10.00	10.00	45.00
	v) NBRI	Continuing	2.91	3.05	3.20	3.15	3.50	15.81
		New	0.70	0.42	0.44	0.46	0.48	2.50
Sub-Area:								
Antigen development	vi) CFB (Delhi)	Continuing	1.00	1.00	1.00	1.00	1.00	5.00
		New	9.00	7.50	6.00	3.00	3.00	28.50
II. New sub-group			-	-	-	-	-	-

5. Financial Projections

I. Sub-Area:	Laboratory		1985-86	1986-87	1987-88	1988-89	1989-90	Total
Development of technology	i) CDRI	Continuing	20.00	15.00	10.76	-	-	45.76
		New	21.40	28.78	35.00	39.99	42.23	167.40
	ii) NCL	Continuing	30.00	45.00	30.00	10.00	-	115.00
		New	30.00	45.00	60.00	20.00	30.00	185.00
	iii) RRL (Bhu)	Continuing	1.65	-	-	-	-	1.65
		New	2.34	2.93	3.32	4.11	4.40	17.10
	iv) RRL (Jammu)	Continuing	7.00	7.00	7.00	7.00	7.00	35.00
		New	-	-	-	-	-	-
	v) RRL (Jor)	Continuing	2.50	2.50	2.00	2.00	2.00	11.00
		New	1.50	1.50	1.00	2.00	3.00	9.00
II. New sub-group			-	-	-	-	-	-

	CDRI	IICB	NBRI	NCL	RRL (Bhu)	RRL (Hyd)	RRL (Jammu)	RRL (Jor)	CFB
g. Trouble shooting and assistance.	-						-		-
h. General consultancy and advice.	7						-		-
Financial flows/earnings indicators.									
Cash flow from sponsored projects (Rs. in lacs)									
Cash flow from consultancy, royalty, premia, analytical and testing services and publications (Rs. in lacs)	1.5					4.0	0.225		-
External funding for projects/facilities (Rs. in lacs)	3.5					9.75	1.00	0.3	0.007
	220.0								
Value of production as a result of exploitation of products and processes developed by the laboratory (Rs. in lacs)	not available					215.0	salaki 50L/pa xanthotoxin 30L/pa		
Education and training indicators.									
a. DS output from universities with the support of DGSIR (EMR)									
Training courses organised and the number of persons trained:									
Internal (Indian)	15		2						124
Foreign	10		5				10		1
Fees received									0.375

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2.0 Perspectives

2.1 National Needs

A study Group of the Indian Council of Social Science Research and Indian Council of Medical Research in its report (1980) has recommended a comprehensive national health care system which would aim to provide health for ally by 2000 A.D. This implies a drastic reduction in morbidity and mortality and particularly infant mortality. It has identified communicable diseases as the major cause of morbidity and mortality. The figures of incidence of important infectious diseases in India (1980) given below indicate the seriousness of the problem.

1.	Tuberculosis	10.00 million
2.	Filaria	30.00 million (240 million at risk)
3.	Malaria	6.8 million
4.	Leprosy	3.2 million
5.	Diarrhoeal diseases (including cholera, amoebiasis, bacillary, dysentery, etc).	103.00 million
6.	Other helminth infections	205.00 million
7.	Venereal diseases	34.00 million

With an almost two-fold increase in life-span and changes in pattern of living due to modernisation and industrialisation, other health problems are also becoming increasingly important e.g. cardiovascular disorders, mental disorders, cancer and occupational health hazards and allergic disorders. Attention has therefore to be focussed on the eradication, or at least effective control of these diseases.

Population explosion, is also a major problem, which if not resolved would seriously hamper the development effort in all sectors. The Study Group has recommended reduction in the net reproduction rate from 1.67 to 1.00 and stabilisation of the population at 1200 million by 2000 A.D.

While the Report has stressed the preventive aspect of health care (improvement in nutritional status and environment, safe drinking water and health education), the importance of the curative aspect has also been emphasised, which implies availability of adequate quantity of safe and effective drugs at the cheapest possible price. The very low health status of our population can be gauged from the Rs.20/- per capita consumption of modern drugs in India compared to Rs.150/- in U.K. and Rs.250/- in Japan.

Curative measures of health care would need R and D thrust in the following directions.

2.1.1 Development of technology for known drugs

Although most of the bulk drugs are already being made in the country, their total production is insufficient. Of about Rs. 350 crores worth of bulk drugs consumed per year, about 40 is still imported. This import covers both drugs which are made in the country but in inadequate quantity, and those that are not at all manufactured indigenously. The shortfall in the production ranges from 19 to 100. While it is not feasible for any country to be completely self-sufficient in production of drugs, self-sufficiency in production of essential and life-saving drugs is certainly to be aimed at. Here the small-scale sector can play an important role.

Although non-technological constraints are known to be mainly responsible for hindering the stepping up of production, in some cases non-availability of technology hampers setting up of new units, because horizontal transfer of technology in the country is not a common practice.

Hence, standardisation innovation of technology for bulk drugs particularly of categories I and II and of their intermediates, based on use of indigenously available raw materials and equipment has to be a continuing effort of national laboratories. This effort should be coordinated with universities, technological institutes and drug industry. Indigenous or imported technology needs to be continuously updated in keeping with scientific and

technological advances made in other countries, so as to increase yields, reduce cost of production and provide drugs at a cheaper price to the Indian consumer and be able to compete in the international market.

2.1.2 New drug development

There is need to develop better drugs, to replace existing drugs-better from the point of view of greater efficacy, less side-effects, facility of administration and less cost. New drugs are also needed for conditions for which none are available. Although a number of drug companies have established in-house R and D laboratories, they are concentrating on process development and formulation research or testing of formulations; very few are engaged in development of new drugs due to high cost and high risk of such R and D. Hence, the national laboratories have to play a major role in this area. However, their effort should be coordinated with the chemical laboratories of universities and schools of pharmaceutical sciences where synthesis of new chemical molecules or isolation of natural products is being done and with pharmacological laboratories of medical institutions. Attempts should also be made to involve the pharmaceutical industry particularly at the stage of clinical trial of candidate drugs. The short-comings of existing therapy for some of the conditions relevant to India are outlined below:

i) Filariasis:

The only effective drug is diethylcarbamazine which kills the microfilariae (mf) in the host system, but does not affect the adult worms which continue to produce microfilariae and thus the disease is not eradicated. DEC also has undsirable side-effects. The need is for a drug which would kill the mf and kill or sterilise the adult worms. Alternatively, a combination of drugs could be used, one effective against mf and the other against adult worms. The need is thus for a safe macrofilaricide, with or without microfilaricidal activities.

ii) Malaria:

The disease has staged a comeback because of various reasons which include development of resistance to drugs by parasites. The common form of the disease in India is vivax (relapsing) malaria, for which the only effective radical curative drug is primaquine, which is imported and is not free of side-effects. There is need to find new anti-relapse drugs which will act on the dormant tissue stages (hypnozoite) of the parasite. A greater danger is the appearance of falciparum (malignant) malaria which has established itself in the north-eastern region and is spreading. P. falciparum is becoming resistant to chloroquin and very few really safe and effective drugs are available against the chloroquin-resistant parasites. Moreover resistance to some of the newly introduced drugs like fansider (pyrimethamine + sulfadoxine) develops very quickly. Thus development of non-8-amino-quinoline anti-relapse drugs and highly active blood schizontocides against multi-resistant P. falciparum is necessary.

iii) Amoebiasis:

Existing drugs are rather toxic and kill only the active trophozoite form of the parasite but have no effect on the trophozoites buried deep in the lumen of the GI tract and on the cyst form; after cessation of therapy, cysts again excyst to trophozoites and disease recurs. Safer and more effective drugs are, therefore, required which would kill both the trophozoites and the cysts or make the latter excyst and then kill them.

iv) Leprosy:

Dapsone is mainly used for therapy, but it is very slow-acting and treatment is prolonged; appearance of resistance to the drug is being increasingly reported. Rifampicin is useful in resistant cases but is very expensive for mass use; it has some serious side-effects also. The need is therefore to develop better chemotherapeutic agents to reduce period and the cost of treatment, and incidence of toxic effects.

v) Population control:

This is perhaps the most serious problem facing the country as progress in all sectors of the economy is closely linked to population stabilisation. In the development of contraceptive technology, one single method may not be ideal in all situations because of the wide variations in socio-economic and religio-cultural becakground of people. A multi-pronged (Cafetaria) approach is required: post-coital oral contraceptives, male contraceptive pill, vas- and tube-occluding agents, spermicides, once a month menses inducer (early abortifacient).

vi) Drugs for central nervous system and cardiovascular disorders

Many of these diseases due to stress and strain are also associated with increased life-span, being basically geriatric problems. Although foreign drug firms have a major interest in development of drugs for psychiatric disorders, hypertension, cardiac arrhythmias etc., we cannot afford to be totally indifferent, since drugs developed abroad take a long time to be introduced and are also very expensive. Moreover, a laboratory involved in new drug development has per force to create facilities for in-depth study of drug side-effects on CVS and CNS. To make optimum use of these facilities, they should also be utilised for developing new drugs acting on these systems. Such drugs also have a large export potential.

2.1.3 New Drug Delivery Forms

R and D in this area would help in making better use of known drugs. Attention has to be focussed on pro-drugs, targeted delivery of drugs and long-acting forms of drugs; the latter would be particularly sutiable in our country where doctor-patient ratio is very low and will continue to be so for many years to come and such drug forms would need less frequent administration and less supervision.

2.1.4 Development of drugs and intermediates from natural sources:

Our country has a long tradition of use of plant remedies in the Ayurvedic and Unani systems of medicine. Around 75% of the population, particularly in rural areas, still prefer and depend on indigenous remedies, and are likely to continue to do so for many years to come. Moreover, our resources of plants are both varied and abundant. Investigation of these herbal remedies with a view to standardising their preparation, quality control of raw materials and, wherever possible, of the final products, establishing their safety and efficacy is therefore, necessary. Priority should be given to drugs reported to be [illegible] for chronic non-life threatening diseases and for conditions for which suitable drugs are not available in the modern system. Search for new drugs and intermediates from terrestrial plants by broad screening programmes also needs to be continued. A new source of possible drugs is marine flora and fauna.

2.1.5 Development and production of allergens for diagnosis and immuno-therapy:

An estimated 20 million people in this country suffer from asthama and rhinitis due to inhalation of airborne particles and ingestion of some foods. A national survey has provided detailed information on incidence of pollen and fungal spores in the atmosphere of various regions of India in different seasons. A beginning has been made to identify the causative factors and treat the conditions by immunotherapy.

2.2 International trends

In spite of the advances made in the discovery of new drugs, except for infectious diseases and those caused by vitamin or hormone deficiencies, for a number of other ailments the therapy available is merely palliative and supportive rather than curative. For some diseases suitable drugs are not available, and even existing drugs are going out of use because of problems of drug resistance. There are also wide gaps in the availability of suitable drugs for many targets in fertility regulation. Several international studies such as the Adelphi study, and those by the office of Health Economics, London and some major pharmaceutical

companies have identified the following areas in which there are major gaps in the availability of drugs, and in which drug research should concentrate. These are:

1. Cancer
2. Fertility regulation
3. Arhritic diseases
4. Systemic fungal infections
5. Degenerative disorders
6. Viral infections
7. Cardiovascular disorders
8. Tropical parasitic diseases
9. Auto-immune diseases
10. Mental disorders

Drug research in western countries is mainly being carried out by private pharmaceutical firms, many of which are multi-national, and hence their emphasis is on discovery of new drugs for conditions more relevant to their countries, as sale of such drugs would be more profitable. Drugs for tropical diseases and fertility regulation are low in their order of priority, although 2/3 of the world population, which lives in the developing countries need such drugs. WHO has identified six tropical communicable diseases and fertility regulation as areas of priority and have focussed the attention of the world scientific community to find drugs for these.

The increasingly stringent standards of efficacy and safety required by the drug control authorities of the major drug producing/introducing countries, and consequent increase in the cost and time required for developing new drugs, have led to a sharp fall in the rate of introduction of new chemical entities in the last decade. Multi-national companies are, therefore focussing attention on finding new uses of known drugs which would require no additional investment.

Another trend in drug research is development of new delivery forms of known drugs which would give better therapeutic response and would require a much smaller dose, thus reducing cost of treatment and the danger of side-effects. Targetting of drugs to the specific site in the body has revolutionised the concept of dosage schedule.

Long-acting forms of drugs are also being developed. These provide slow, uniform and continuous supply of drugs; there is no need for repeated doses and a steady serum level of drug is

maintained. These are particularly useful in chronic conditions like leprosy and tuberculosis, and for fertility control where therapy is needed for prolonged periods. Osmotic pumps, drop counters and transdermal devices are some of the methods being tried.

Discovery of new drugs has so far been based largely on synthesis of new compounds, based on leads provided by compounds of known biological activity and a broad screening programme. With the gradual narrowing of the areasof unresolved therapeutic problems, it appears that for 'simpler' diseases, drugs have been discovered, and those diseases that are left are biologically more complex. If new drugs have to be discovered in these unresolved areas, the biochemistry of the disease must be better understood. This underscores the need for basic research also. An important trend in international pharmaceutical industry is to step up basic research to understand the fundamentals of life processes and major pharmaceutical companies have established R and D facilities in the areas of cell and molecular biology.

An analysis of the areas in which new drugs are not available indicates that these are the same areas in which suitable experimental models do not exist. Another trend, therefore, is to develop new screening models, both in vitro and in vivo, which would give data that would be relevant to the human situation.

Computers are being used more and more for the design of active molecules. For example, if the shape of the binding sites on an enzyme can be visualised, then the drug molecule best fitting this site can be calculated with the aid of the computer. Computer systems help in storing and analysing quantitative structure-activity data. By interacting different sets of properties, a molecule can be so designed that when synthesised it would have the desired activity. Thus there is no need to synthesise and screen a large number of compounds most of which turn out to be inactive or have undesired toxic effects.

Respiratory ailments such as asthma and rhinitis are caused by inhalation of pollents and fungal spores etc. and ingestion of some foods. In developed countries diagnosis and immunotherapy of such ailments is done using causative allergens. Commercial concerns are karketing products based on airborne particles in their atmosphere for diagnosis and hyposensitisation of respiratory allergy patients. Work is being done on standardisation and improvement of quality of allergens.

3.0 S&T Programme for Seventh Plan

The following Table gives the continuing and new programmes, laboratory-wise, of the nine participating laboratories. The programmes have been broadly classified into four sub-areas: (i) Technology development, (ii) New synthetic drugs, (iii) Drugs from natural sources and (iv) Antigens. The work of CDRI relates to the first three sub-areas, and the other laboratories are concerned with certain aspects in one or two of the four sub-areas.

Five laboratories (CDRI, NCL, RRL-Bhu, RRL-Jammu and RRL-Jorhat) have technology development projects - mainly for synthetic drugs. There is no special thrust on any particular therapeutic or chemical categories of drugs.

In the sub-area of new synthetic drugs, only CDRI has a comprehensive programme of design and synthesis of potential drugs for a wide range of therapeutic conditions and for fertility control, and it has built up the necessary capabilities for pre-clinical and clinical development studies in the Institute itself. IICB has interest in anti-leishmania, anti-parkinsonism, anti-hypertensive and anticancer drugs and RRL-Jammu in anti-protozoal, anti-fertility, anti-asthmatic and oxytocic drugs. RRL(Bhu) has interest in antimalarials. RRL, Hyderabad is working on the development of drugs in the area of central nervous system depressants, blood pressure reducing, cholesterol and triglyceride reducing, analgesic and antiinflammatory agents. It involves the synthesis and design of a variety of novel and new molecules.

The search for drugs from terrestrial plants and marine sources is limited to CDRI, IICB, RRL-Hyd. The interest of NBRI is restricted specifically to botanical standardisation of herbal drugs and collection of germ plasm.

CFB is concerned only with development of antigens for diagnosis and immunotherapy of allergic asthma and rhinitis and has also set up a production unti. No other laboratory is undertaking production commercially.

S.No. 1	Name of the Laboratory 2	Technology Development 3	New Synthetic Drugs 4	Drugs from Natural sources 5
i)	CDRI a) Continuing	i) Technology for mefloquines, estrones, norethisterone, norgestrel, dipyramidol, naproxen, ibuprofen, lioresal, cephalosporins, synthetic penicillins.	i) New drugs for fertility regulation. ii) New drugs for filariasis and other helminth infections iii) New drugs for malaria iv) New anti-amoebic agents v) New drugs for cardio-vascular and nervous system disorders vi) New drug forms and delivery systems vii) Clinical trials of CDRI developed drugs: tubal occluding agent 74/575; antifilarial centperazine; anti-depressant Centpropazine; neuroleptic Centbutindole; neuromuscular blocker Chandonium iodide; hypolipidaemic 80/574; and of antifilarial Mefloquine	i) New drugs for disorders of carbohydrate and lipid metabolism ii) Natural products as source of drugs iii) Clinical trials of curcumin, gugulipid, consap, Boerrhavia diffusa, medicated cervical dilator

1	2	3	4	5
	b) New	i) Technology for ketoconazole, iodised oils, nifedepine, azothiaprin, clabulinic acid, nocardicin, exoprenaline, flunisal, flubendazole, fenbrufen, captopril praziquantel, rifampicin	i) QSAR studies ii) Use of computer graphics for drug design iii) Depot preparations of chemotherapeutic drugs	i) Development of natural products coleonol, bacosides and kutkin
		ii) Upscaling and updating of processes already standardised		
		iii) Scaling up of laboratory processes for CDRI developed drugs		
ii)	CFB (Delhi)			
	a) Continuing	i) Standardisation of new antigens for immunotherapy	--	--
	b) New	i) Standardisation of quick and non-invasive methods to determine antigen potency	--	--
		ii) In vitro methods for allergy diagnosis		
		iii) Long-acting antigens		
iii)	IICB			
	a) Continuing	--	i) Synthesis of ajmalicine analogues as antihypertensives ii) Synthesis of dimeric alkaloids as anti-cancer drugs	i) Drugs from terrestrial plants and marine sources

1	2	3	4	5
	b) New	-	i) Development of better drugs for leishmaniasis ii) Pyridobenzoquinolizines as biodynamic agents iii) New antiparkinsonism drugs iv) New drug delivery systems	i) Development of antifertility drugs
iv)	NBRI			
	a) Continuing	-	-	i) Pharmacognostic and botancial standardisation of herbal drugs and preparations
	b) New	-	-	i) Collection and propagation of germ plasm of herbal drugs ii) Improvement of poppy plants for morphine and codeine content
v)	NCL			
	a) Continuing	i) Technology for dapsone, chlonoquine, synthetic penicillins	-	-
	b) New	i) Technology for B-lactam antibiotics	-	-
		ii) Total synthesis of anti-tumour natural products		
		iii) Total synthesis of macrolides		
		iv) Technology for steroids from Dioscores		

1	2	3	4	5
vi)	RRL (Bhu)			
	a) Continuing	i) Technology for pyrazinamide and morphazinamide	-	-
	b) New	i) Technology for chitin, chitosans and cholesterol from prawn shells	i) Synthesis of new antimalarials	-
		ii) Technology for sitosterols and wax from sugarcane pressmud		
vii)	RRL (Hyd)			
	a) Continuing	-	i) Synthesis of heterocycles as potential drugs	i) Anti-diabetic drugs from plants
	b) New	-	i) Drug delivery systems and prodrugs	i) Drugs from marine sources
viii)	RRL (Jammu)			
	a) Continuing	i) Technology for cortico-steroids and their intermediates	i) Development of new antifertility agents	i) Immunopharmacological drugs from plants
	b) New	i) Technology for steroids and wax from sugar cane pressmud	i) Development of new antiamoebic drugs	-
		ii) Technology for xanthatoxin from H.candicans	ii) Analogues of vasicine as bronchodilators oxytocies and anti-asthmatics	
ix)	RRL (Jorhat)			
	a) Continuing	i) Development of technology for pentazocine	-	-
	b) New	i) Development of technology for flurazepam, ketazolam, etoprophen, ibuprofen	-	-

Appendix III-B

3. Expected outputs in VII Plan

Laboratory	Technology Development	Product Development	Publications/ Patents
CDRI	Mefloquine, norethisterone, norgestrel, dipyramidol, naproxen, cephalosporins, ketoconazole, tolnaftate, iodised oils, nifedipine, azathioprin, clavulinic acid, nocardicin, hexaprenaline, flunisal, flubendazole, fenbrufen, carprofen, praziquantel, rifampicin. (20)	Clinical trials will be completed of: tubal occluding agent 74/575, Boerhavia diffusa for control of IUD-associated bleeding, medicated cervical dilators, antifilarial Centperazine, antimalarial mefloquine, antidepressant Centpropazine, neuroleptic Centbutindole, neuromuscular blocker Chandonium iodide, hypolipidaemics 80/574 and gugulipid, contraceptive cream, anti-hypertensive coleonol.	300
CFB	Identification of newer antigens, preparation of DEPOT antigens.	-	
IICB	-	-	
NBRI	-	Other output Ultramorphology of 20 plants and pharmacognosy of 20 plants and compilation of monograph.	
NCL	Dapsone, chloroquin, ketfrosen, naproxen, pirexicam, vitamin B_6 vitamin E, atenolol, nabepelol, verapamil, nefedefine, captopril, etoboside, daunomycin analogues, parahydroxyphenyl glycine, phenylglycine HCl.	-	Papers about 100 Patents about 20
RRL (Bhu)	Pyrazinamide, steroid intermediates from solasodine and hecogenin, benzocaine/procaine, steroid raw materials from animal and plant sources.		
RRL (Hyd)	PIROGLIRIDE	Clinical trials will be completed of new analgesic, and new anti-inflammatory.	
RRL (Jammu)	Steroids from Preso Mud, TTA Fluorocorticosteroid, Hydrocortisone 11 hydroxylated steroids.	Clinical trials, toxicity data, Biochemical data on new anti-inflammatory, antihepatotoxic, antiprotozoal.	100
RRL (Jorhat)	Pentazocine, flurazepam, ketozolam, ketoprophen, ibuprofen.	-	

4.0 INFRASTRUCTURE NEEDS

i)	CDRI:	Completion of new Chemistry Block Extension of Animal House
ii)	IICB:	Helium liquifier plant, Mass Spectrometer
iii)	RRL (Hyd):	Animal House, Natural Products Laboratory
iv)	RRL (Jammu):	Animal House
v)	RRL (Jorhat):	-
vi)	CFB (Delhi):	Gama counter for RAST techniques IEF Equipment Mill Q water purification systems ELISA Reader Minor equipment

5. Financial Projections

I. Sub-Area:	Laboratory		1985-86	1986-87	1987-88	1988-89	1989-90	Total
Development of technology	i) CDRI	Continuing	20.00	15.00	10.76	-	-	45.76
		New	21.40	28.78	35.00	39.99	42.23	167.40
	ii) NCL	Continuing	30.00	45.00	30.00	10.00	-	115.00
		New	30.00	45.00	60.00	20.00	30.00	185.00
	iii) RRL (Bhu)	Continuing	1.65	-	-	-	-	1.65
		New	2.34	2.93	3.32	4.11	4.40	17.10
	iv) RRL (Jammu)	Continuing	7.00	7.00	7.00	7.00	7.00	35.00
		New	-	-	-	-	-	-
	v) RRL (Jor)	Continuing	2.50	2.50	2.00	2.00	2.00	11.00
		New	1.50	1.50	1.00	2.00	3.00	9.00
II. New sub-group			-	-	-	-	-	-

I. Sub-Area:	Laboratory		1985-86	1986-87	1987-88	1988-89	1989-90	Total
Development of new synthetic drugs	i) CDRI	Continuing	80.00	84.91	89.15	77.90	82.23	414.19
		New	41.00	42.46	44.57	38.96	41.12	208.11
	ii) RRL (Hyd)	Continuing	4.00	2.00	2.00	2.00	2.00	12.00
		New	11.50	2.00	2.00	2.00	2.00	19.50
	iii) RRL (Jammu)	Continuing	10.00	10.00	10.00	7.50	7.50	45.00
		New	7,50	7.50	10.00	10.00	10.00	45.00
	iv) IICB (Cal)	Continuing	3.50	7.60	8.00	7.50	6.00	32.60
		New	3.50	8.00	8.00	7.50	6.00	33.00
I. Sub-Area								
Drugs from natural sources	i) CDRI	Continuing	25.60	26.89	28.16	24.60	26.00	131.25
		New	12.80	13.45	14.08	12.31	13.00	65.64
	ii) IICB (Cal)	Continuing	4.00	8.00	8.30	8.00	6.80	35.10
		New	-	-	-	-	-	-
	iii) RRL (Hyd)	Continuing	4.00	2.00	2.00	2.00	2.00	12.00
		New	4.00	2.00	2.00	2.00	2.00	12.00
	iv) RRL (Jammu)	Continuing	10.00	10,00	10.00	7.50	7.50	45.00
		New	7.50	7.50	10.00	10.00	10.00	45.00
	v) NBRI	Continuing	2.91	3.05	3.20	3.15	3.50	15.81
		New	0.70	0.42	0.44	0.46	0.48	2.50
Sub-Area:								
Antigen development	vi) CFB (Delhi)	Continuing	1.00	1.00	1.00	1.00	1.00	5.00
		New	9.00	7.50	6.00	3.00	3.00	28.50
II. New sub-group			-	-	-	-	-	-